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REMOTE FLUOROSCOPIC CONTROL OF RADIATION THERAPY BY SCREEN INTENSIFICATION

PRELIMINARY REPORT*†

By RUSSELL H. MORGAN, RALPH E. STURM, LOWELL S. MILLER, *and* DANIEL J. TORRANCE
BALTIMORE, MARYLAND

DURING the last few years, a great deal of effort has been expended on the development of instruments whereby the brightness of the fluoroscopic image may be increased by many times. This work has been motivated primarily by the need for improved fluoroscopic acuity in the field of roentgen diagnosis. However, as the day approaches when practical fluoroscopic screen intensifiers will be available, it appears that these devices will not only be of great value in diagnostic roentgenology, but in radiation therapy as well.

In the past, fluoroscopic screens have been used by a number of radiation therapists for the alignment of lesions under treatment. The procedure which has usually been followed by these workers includes the placement of the patient beneath the roentgen tube with the beam of radiation centered upon the lesion as closely as possible. By means of the fluoroscopic screen, the radiation transmitted by the patient is then observed by the therapist, who thereby is able to correct any misalignment which may exist.

The need for fluoroscopic control in radiation therapy is so obvious that few will dispute it. Not only is one able to maintain the relationship of the radiation to the lesion more satisfactorily with such a technique, but also, since one is certain of this alignment, the size of the irradiated field can be kept to a minimum. Hence, the volume dosage of tissue may be maintained at the lowest possible level, and the tumor dosage thereby increased without serious reaction.

Although the desirability of fluoroscopic control in radiation therapy is quite clear, such control has not been used widely in the past for a number of reasons. First, the clarity of present-day fluoroscopic screens is not too satisfactory. The use of these screens also requires that the therapist be dark-adapted. Furthermore, the therapist, if he employs fluoroscopic control for many of the treatments he administers

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† The work described in this paper was supported in part by the National Cancer Institute, National Institutes of Health, United States Public Health Service.

each day, will himself receive an undesirably large amount of radiation. This problem has been overcome to some extent by the application of optical devices to the fluoroscopic apparatus by which the images may be reflected to the observing therapist through a window outside of the therapy room. Such devices, however, are frequently difficult to use and, under most circumstances, do not make the fluoroscopic procedure a practical method.

During the past few months, experiments have been in progress on the use of our intensifier in radiation therapy. Before we proceed to a discussion of this application, it may be well for us to review briefly the manner in which the instrument operates. The intensifier is composed of two portions: (a) a radiation detector, and (b) a viewing unit. The radiation detector includes a fluoroscopic screen of conventional type, a high-speed optical system, and an

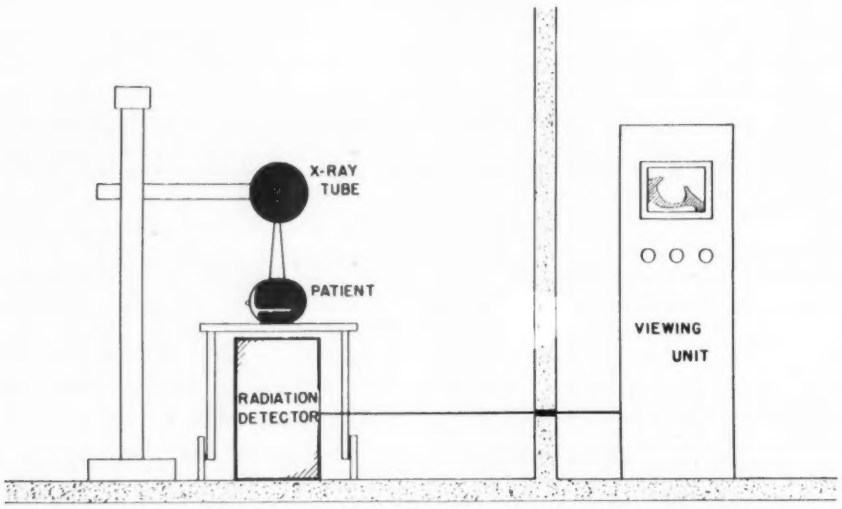

FIG. 1. Schematic diagram illustrating the application of the Johns Hopkins screen intensifier to the monitoring of radiation therapy procedures.

As far as image clarity and dark adaptation are concerned, most of the fluoroscopic screen intensifiers which are now under development in this country and abroad promise to overcome the difficulties which are imposed by conventional fluoroscopic screens. Also, screen intensifiers of the electronic scanning type[1] (*i.e.*, the Johns Hopkins Screen Intensifier) avoid the problem of radiation exposure to the therapist. With this type of intensifier, the viewing screen may be placed completely outside of the hazardous region, in the control room where the radiation therapist is free to observe the fluoroscopic images as long as he wishes without danger of radiation exposure. Indeed, the intensifier permits the therapist to continuously monitor each treatment from beginning to end.

electronic tube, of the image-orthicon type. The fluoroscopic images appearing on the fluorescent screen are focused by the optical system on the photo-sensitive surface of the image-orthicon which converts these images into an electric current. This current is carried to the viewing unit where it is amplified and impressed upon a kinescope (or television picture tube). The kinescope reconverts the electrical signal into a visible image which is similar in pattern to the original fluoroscopic image, but which is many times brighter because of the amplification process in the instrument. Furthermore, since the instrument overcomes some of the deficiencies of the eye when operating at the low levels of brightness of conventional fluoroscopy, the bright fluoroscopic image on the kinescope may be made

to possess greater clarity than that of conventional unintensified fluoroscopic images.

The application of the screen intensifier to radiation therapy is shown schematically in Figure 1. The regular therapy beam from a roentgen tube passes down to irradiate the patient positioned on a table below. Beneath the patient, so that it intercepts the beam as it emerges, is located the radiation detector portion of the screen intensifier. Hence, the radiation detector "sees" the anatomical region under treatment. The electrical signal generated by the detector is carried outside of the therapy room to the viewing unit in the control area, where the fluoroscopic picture is reconstructed and observed in safety by the radiation therapist.

The therapeutic applications which we have investigated for the intensifier include the fluoroscopic alignment of lesions of the head, neck and thorax. Many lesions in these regions may be seen directly by fluoroscopy or are sufficiently close to bony landmarks which can be readily identified that their location is not difficult. For example, we have found that in the treatment of pituitary adenomas, the alignment of the radiation with the lesion is simple, since the sella turcica can be readily identified by fluoroscopic observation. We have also found that lesions of structures which can be opacified by radiopaque substances may be treated effectively by this technique. In one of our patients with a carcinoma of the esophagus, there was little difficulty in aligning the roentgen beam with the lesion when the patient swallowed thick barium. Figure 2 comprises a few frames of a motion picture taken of the kinescopic screen of the intensifier of this patient. It was interesting that the upper and lower limits of the lesion were better identified on the kinescopic screen than on conventional roentgenograms made before the treatment was begun.

Although we have focused our attention primarily on lesions above the diaphragm, there are many lesions below the diaphragm which are amenable to remote fluoroscopic control. Lesions of the spine and pelvis may be treated to great advantage by the method, since the radiation may be directed to these lesions with much greater certainty than has heretofore been possible. Also, it appears that many lesions below the diaphragm which exist in tissues which are not normally visible by fluoroscopy can be made visible either by the use of radiopaque substances or by the surgical implantation of radiopaque objects of reference.

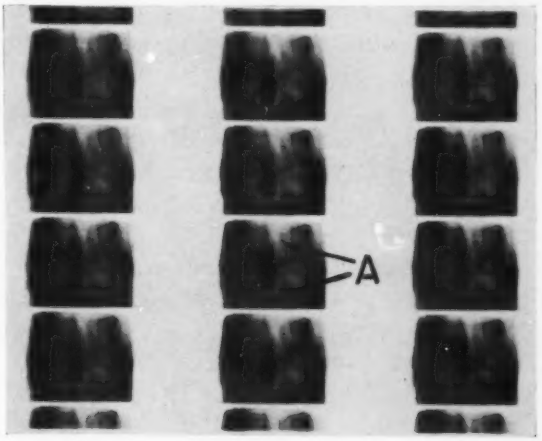

Fig. 2. Several motion picture frames taken from the viewing screen of the intensifier during treatment of a patient with carcinoma of the esophagus. The upper and lower limits of the lesion are shown at *A*. The large focal spot of the therapy tube causes considerable degradation of the image quality. Work is now progressing on the development of therapy tubes with small focal spots, comparable to those used in diagnostic roentgenology.

At this time, there does not seem to be serious limitation to the fluoroscopic method in the radiation therapy. The procedure appears to be quite practicable. Research is now going forward on the development of screen intensifiers designed specifically for the therapy application, and it is anticipated that these instruments will be generally adaptable to most therapy equipment as it exists today. Doubtless, we do not yet appreciate many of the advantages which may accrue from the use of such apparatus. However, some are already very apparent. The alignment of the roentgen beam with

the lesion under treatment will be enormously more certain. Furthermore, when each treatment is monitored continuously, movement of the patient during treatment can be immediately recognized and corrected. This relationship between movement and tumor irradiation is particularly important in rotational therapy. Indeed, experiments which we have conducted in such therapy indicate that fluoroscopic control with screen intensification will overcome many of the problems which have been encountered in rotational therapy in the past.

Undoubtedly, many secondary advantages will accrue from remote fluoroscopic control. We have found, for example, that it is readily possible to make a simple photographic record of each radiation treatment. The kinescopic screen is sufficiently bright that photography is a simple procedure. In research studies, the advantages of such records are obvious.

The foregoing constitutes a preliminary report of early work with remote fluoroscopic control of radiation therapy. During the next few months, we shall direct our principal attention to the completion of screen intensification equipment designed specifically for radiation therapy applications. Following this, our attention will be concerned with the controlled study of patients with this technique to determine its advantages and disadvantages. As data from these experimental studies accrue, they will be published as quickly as significant conclusions can be derived from them.

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Baltimore 5, Maryland

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RADIATION THERAPY IN CARCINOMA OF THE THORACIC ESOPHAGUS*

By DENIS C. ADLER, M.D., *and* PAUL H. DEEB, M.D.
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WITH the remarkable recent progress in thoracic surgery in the treatment of carcinoma of the esophagus, there was a decrease in the interest in radiation therapy of this disease in this country. Numerous reports, especially in the American literature, showed poor results with radiation therapy in carcinoma of the esophagus.

At a recent local radiological meeting, when a prominent chest surgeon[2] reported his results in resection of carcinoma of the esophagus, the chairman of the meeting brought up the subject of radiation therapy. The opinion voiced by the large number of radiologists present suggested that they would prefer to discard radiation therapy entirely in the treatment of carcinoma of the esophagus. In view of this tendency, it was believed that it would be worth while to report 3 cases observed during the last seven years at the White Memorial Hospital which came to autopsy, or esophagoscopic biopsy, following extensive radiation therapy for carcinoma of the thoracic esophagus. There was no evidence of residual neoplasm in either of the 2 cases who died eighteen and thirty months after the beginning of radiation therapy.

FIG. 1. Case 1. December 7, 1943. Partial obstruction with filling defect in the upper third of the thoracic esophagus. The narrowing and the mucosal destruction involves an approximately 8 cm. segment.

REPORT OF CASES

CASE 1. M.L. The first case was that of a woman, aged seventy-three, who has been under observation in the White Memorial Clinic for various complaints and was treated in Medicine, Ear, Nose and Throat, and Orthopedics Departments. In June, 1943, she noticed some vague pain in the substernal region during swallowing. She came to the clinic with this complaint in November, 1943. Physical examination was negative at this time. She returned on December 6, complaining of malaise, weakness, and further difficulty in swallowing. She had to wash solid food down with fluids. Roentgen study of the esophagus (Fig. 1) was done on December 6, 1943, and revealed the presence of a filling defect just below the clavicle, occupying an 8 cm. length of the esophagus. The filling defect was just above the aortic arch. It did not produce complete obstruction. There was a definite canalization.

Esophagoscopy on December 31, 1943, showed at the 20 cm. level a pale, fungating, friable annular growth encroaching upon the lumen of the esophagus. The mass was partly polypoid and bled easily upon instrumentation.

* From the Department of Radiology (Chief, Walter L. Stilson, M.D.), White Memorial Hospital, College of Medical Evangelists, Los Angeles, California.

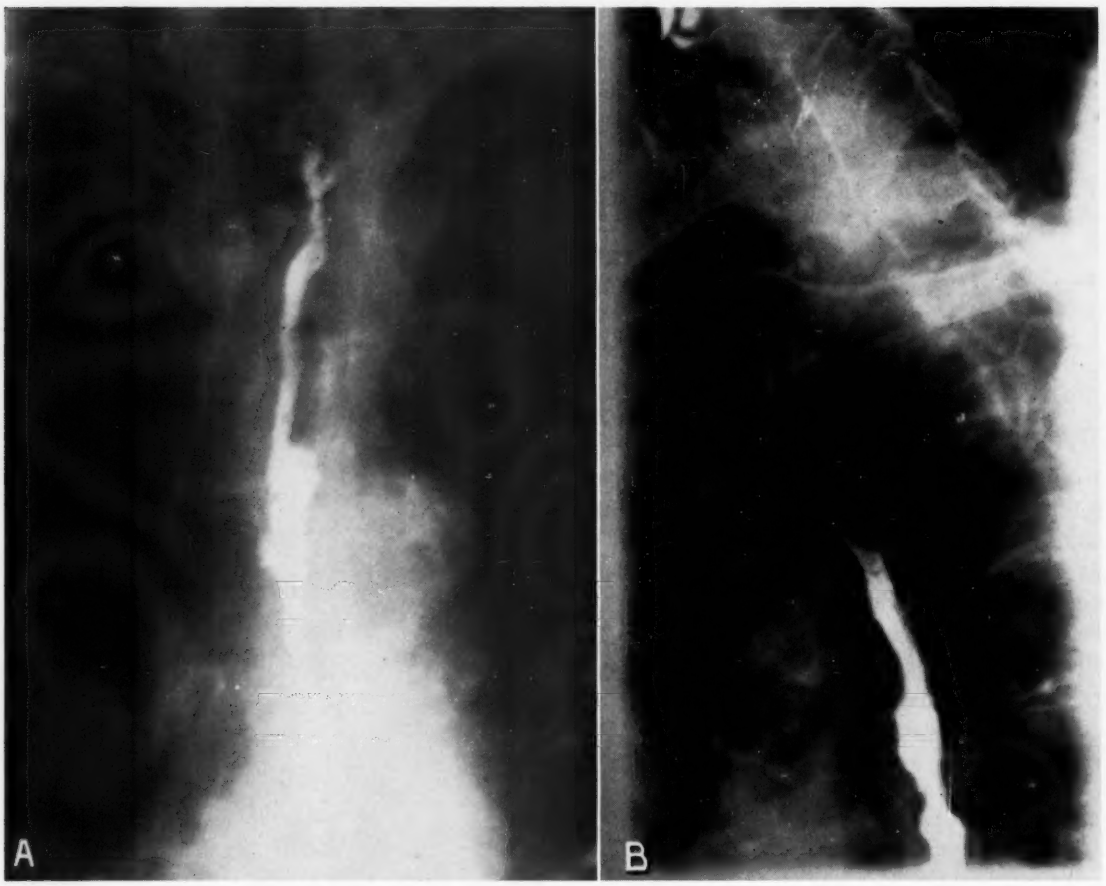

FIG. 2. Case 1. January 3, 1945. (*A*) Anteroposterior and (*B*) oblique spot roentgenograms show that the irregular narrowing of the upper third of the esophagus has persisted. The large filling defect with the partial obstruction has disappeared. Normal mucosal folds are not demonstrated.

A biopsy specimen was taken. Histopathological report: (Fig. 4*A*) Squamous cell carcinoma showing considerable tendency to keratinization. Mitoses were fairly numerous.

Radiation therapy was started on January 10, 1944. Right and left anterior portals 10 by 10 cm. were used. However, after administration of 400 r it was felt that the length of these portals was not sufficient and also that more portals could be used. The treatment was continued through six portals: left and right anterolateral 5 by 15 cm.; anterior medial, 5 by 15 cm.; posterior medial, 10 by 15 cm., and right and left posterolateral oblique fields of 5 by 15 cm. The left anterior lateral, middle anterior and the right anterior lateral portals received 2,500 r each. The other portals received somewhat less radiation. The mid-posterior portal received 2,000 r, the right posterior oblique, 1,800 r, and the left posterior oblique, 1,700 r. The radiation therapy was given from January 14 to March 17, 1944, in daily doses of 200 r, treating only one field per day. From January 24 to March 6, 1944, the daily exposure was 300 r. After four days of treatment a Levine tube was introduced in view of the marked difficulty in swallowing. Six days later it was removed and was re-inserted. When about half of the treatment was completed the patient was able to take semisolids in addition to liquids.

Roentgenoscopic examination on March 30, 1944, showed marked improvement in the barium swallowing. The patient received radium treatment on July 21 and August 18, 1944. On July 21, 1944, an 80 mg. radium tandem with an active length of 5.5 cm. was applied for six hours, with a dosage of 480 milligram hours. The calculated tissue dose at 1 cm. depth from the axis of the applicator was 1,480 gamma roentgens.

On August 18, 1944, a 60 mg. radium tandem, with the radium homogeneously distributed, was applied for five hours—approximately 925 gamma roentgens at 1 cm. depth. The active length of the applicator was 5.5 cm.

Esophagoscopy on October 23, 1944, showed a stricture in the region of the lesion. There was no definite evidence of recurrence. Biopsy was obtained. Histopathological examination showed chronic inflammation of the esophagus (Fig. 4*B*). No tumor cells were found.

In January, 1945, the patient developed pains in the mid-dorsal region. Roentgen examination on January 3, 1945, and February 22, 1945, showed that the narrowing of the esophagus had persisted (Fig. 2 and 3). Roentgenograms of March 20, 1945, showed wedging of the body of the eighth dorsal vertebra. There was no evidence of bone destruction. The compression appeared since a previous roentgenographic examination of December, 1944. The impression of the radiologist was that the collapse was secondary to senile atrophy and possibly to changes related to irradiation.

In April, 1945, the patient developed epigastric pain. She had a temperature of 103.5° F. and dysphagia. On May 23, 1945, the patient appeared to be confused. Physical examination showed emaciation. There was progressive lethargia and she died on May 29, 1945.

Summary of the Autopsy Findings. The esophagus showed adherence to the mediastinal tissues. The adhesions extended down to the level of the tracheal bifurcation where a small purulent collection was noted in the adjacent mediastinum. The infection appeared to be localized. After opening the esophagus, a thickening of the walls was noted at the level of the second rib extending to the carina. At the cephalic end of the thickening there was a stricture, the diameter of which was 8 mm. The mucosa appeared to be atrophied throughout the 7 cm. segment and at the lower margin there was an ulcer measuring 1 cm. There was marked thinning of the wall. This was probably responsible for the local mediastinitis. The esophagus above the lesion did not appear to be dilated. Microscopically the mucosa was absent (Fig. 4*C*). There was irregular necrotic material in place of the mucosa. No signs of tumor were noted.

Comment. This woman, aged seventy-three, whose general condition was very poor at the onset of therapy, reacted unsatisfactorily to extensive irradiation. During most of her postirradiation course a Levine tube had to be kept in the esophagus because of progressive stenosis. The amount of radiation and the long time interval between the completion of the external irradiation and the intracavitary radium treatment was far from what would be expected from a sound, well planned course of irradiation. No depth dose was calculated.

Fig. 3. Case 1. February 2, 1945. Funnel-shaped narrowing of the esophagus without nodularity or ulceration.

The autopsy findings called our attention to this case. The effects and complications of heavy irradiation were obvious. There was ulceration with localized mediastinitis and abscess formation. Possible radiation changes were also present in one of the dorsal vertebrae at the level of the lesion.

The lack of carcinoma cells has impressed us with the fact that a rather large advanced tumor could be sterilized with a combination of the generally available 200 kv. radiation and intracavitary radium therapy.

Case II. J.W. The second case was that of a

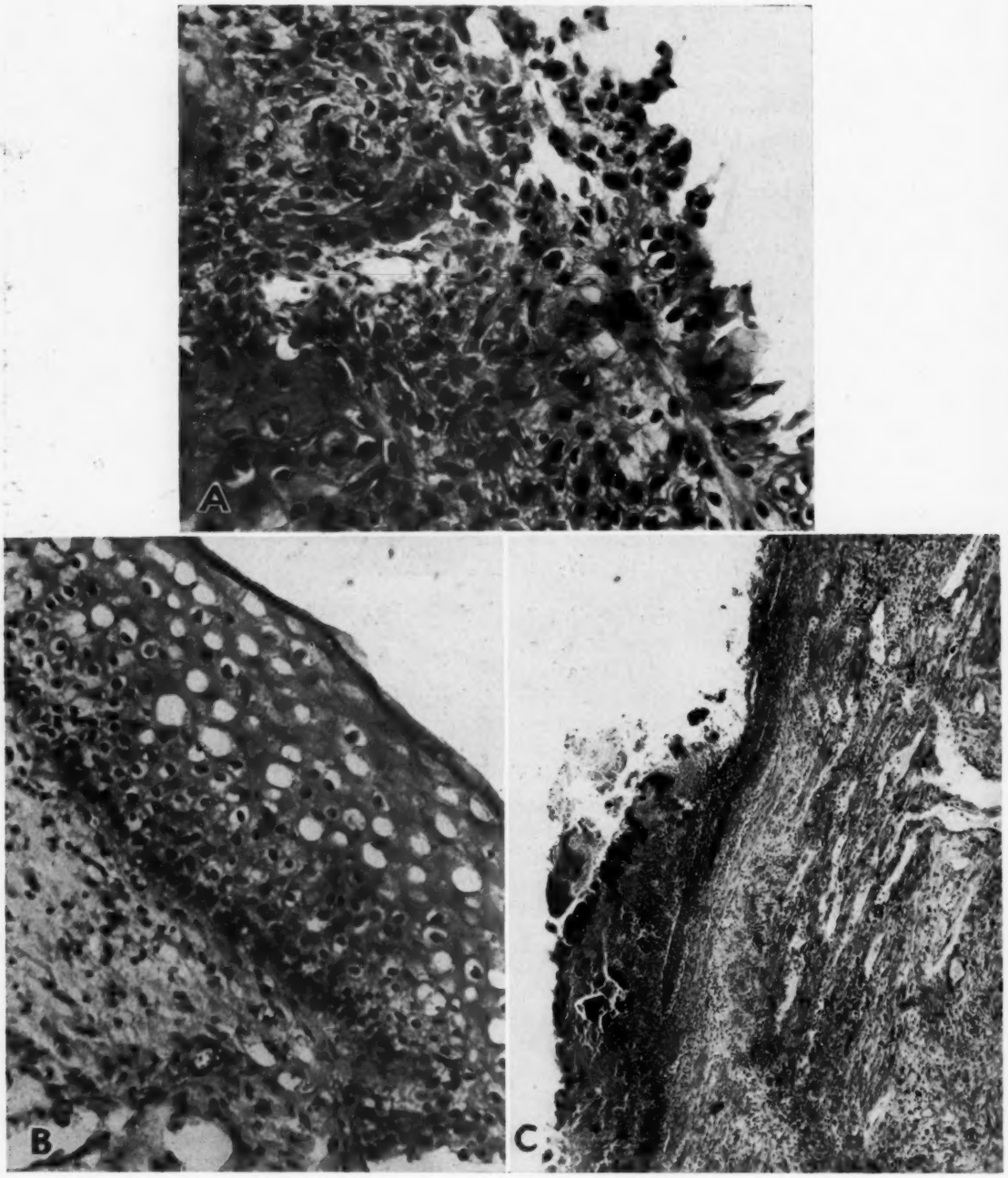

FIG. 4. Case 1. (*A*) Photomicrograph, December 31, 1943. Biopsy through the esophagoscope revealed a neoplasm consisting of squamous cells. There is wide variation of the size and staining reaction of the nucleoli. *Diagnosis:* Squamous carcinoma, Grade 3. (*B*) October 23, 1944. Esophagoscopic biopsy showed fibromuscular tissue covered with squamous cells and demonstrating some chronic inflammation. No malignant cells were seen. (*C*) May 29, 1945. The mucosa was absent. Irregular necrotic material was seen. No tumor cells were present.

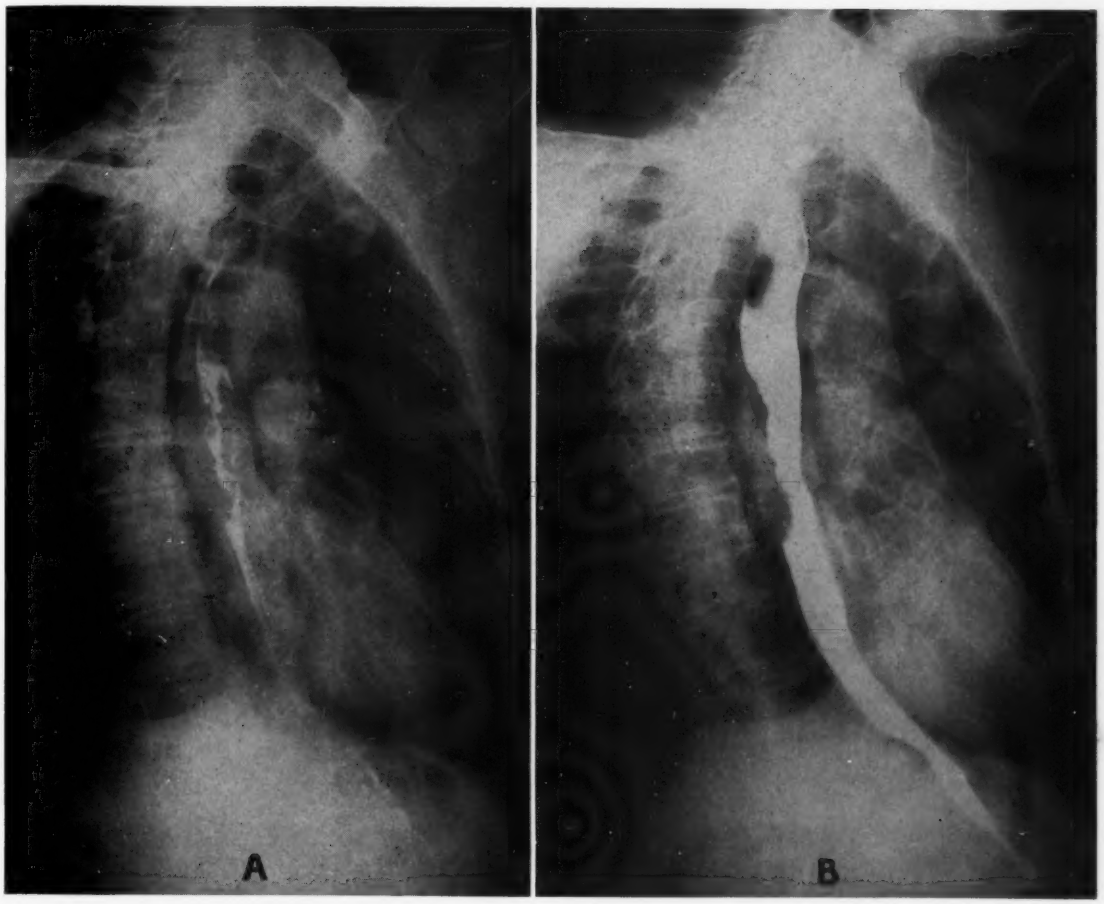

Fig. 5. Case 11. December 17, 1945. (*A*) Ulceration and mucosal irregularity involving a 7 cm. segment of the esophagus. (*B*) The barium-filled esophagus demonstrates a defect with ragged borders extending from the posterior wall below the bifurcation.

man, aged sixty-eight, who had had difficulty in swallowing for six months. The first symptom was a burning sensation when swallowing soup. This sensation subsided and he had no complaints up to four weeks before admission, on December 28, 1945, when rather suddenly he was unable to swallow solid food without washing it down with water or milk. He had lost 17 pounds in weight and had no appetite. Roentgen examination on December 13, 1945, showed a 7 cm. irregular filling defect (Fig. 5). Esophagoscopy in December, 1945, showed a bleeding, nodular, friable tumor at the level of the sixth dorsal vertebra, extending downwards. The lumen of the esophagus was only slightly narrowed. Biopsy showed squamous carcinoma, Grade 2. (Fig. 8*A*).

At the time of the esophagoscopy, on December 31, 1945, a radium tandem was inserted containing 2×25 mg. radium with an active length of 3 cm.; 200 mg. hr. (1,060 gamma roentgens at 1 cm. distance) was given. High voltage radiation therapy was started on January 21, 1946, and 1,900 r was given to four 10 by 15 cm. portals over the anterior and posterior mediastinum. The first two-thirds of this course was given with 0.5 mm. Cu plus 1 mm. Al filtration. The remainder was given with 1.0 mm. Cu plus 1.0 mm. Al filtration. External irradiation was completed on February 24, 1946. Two fields were treated daily with 200 r. From February 17, 1946, the daily exposure was decreased to 150 r to each of the two portals.

On March 13, 1946, an additional intracavitary radium treatment was administered. This time 4×25 mg. radium, active length 6 cm., was used for two and a half hours corresponding to

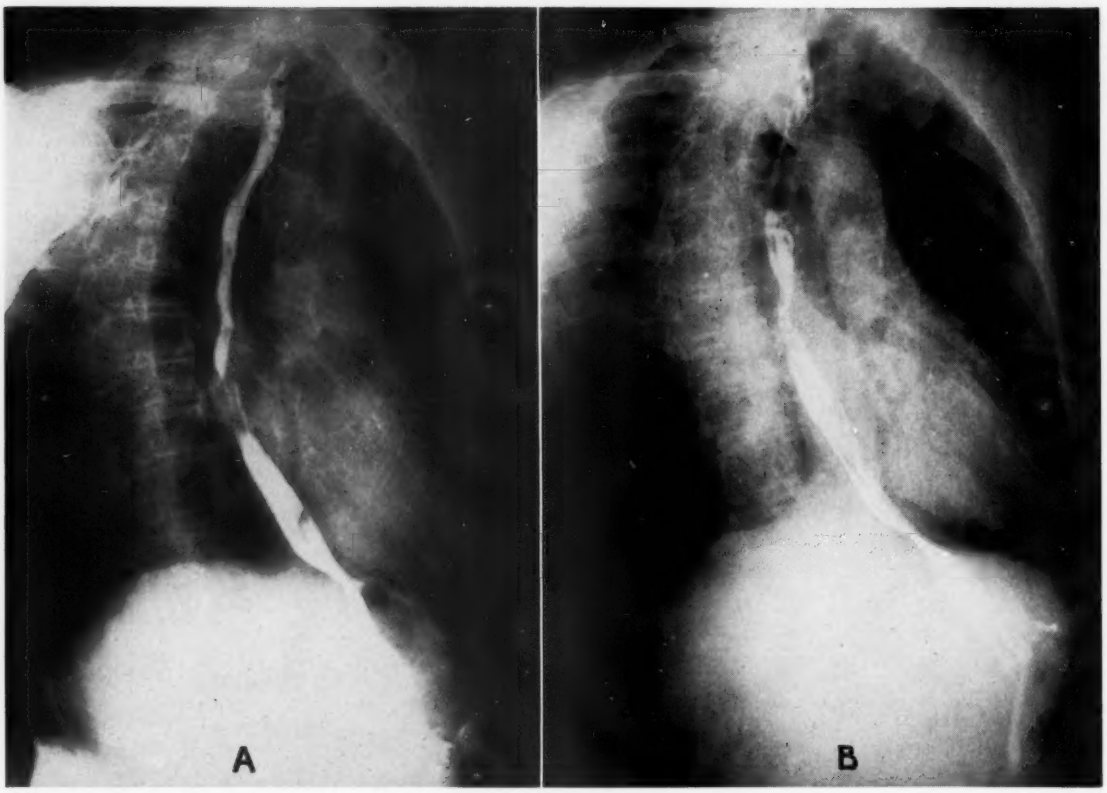

FIG. 6. Case II. (*A*) September 22, 1946. Narrowing of the esophagus with complete disappearance of the filling defect. The ulceration healed and there is some restitution of the longitudinal folds. (*B*) November 1, 1946. Some pliability of the treated segment is also demonstrated.

250 mg. hr. (approximately 730 gamma roentgens at 1 cm. depth). At the same time, esophagoscopy showed that the lumen was quite open. The esophageal wall was smooth and the size of the ulceration had decreased. During the following six months the patient's swallowing improved considerably. He gained 15 pounds. Roentgen examination in September, 1946, showed regression of the mass and narrowing of the esophagus (Fig. 6). In December, 1947, the patient reported that he was unable to swallow larger pieces of food. During the following year the patient was able to eat fairly well. He had several dilations of the esophagus and occasional attacks of acute dysphagia when swallowing meat.

The patient did not return for observation up to October, 1948. At that time he complained of nausea, watery diarrhea and vomiting. He was admitted to the hospital. On physical examination he was found to be lethargic, confused and dehydrated. In the hospital his course was steadily retrogressive and he died On October 21, 1948.

Essential Notes of Autopsy. There was narrowing of the esophagus at the level of the bifurcation of the trachea and there was a 5 cm. mucosal change (Fig. 7). There was very little thickening of the wall or any infiltration resembling carcinoma. The right lung contained multiple firm nodules in all lobes. These nodules measured 5 mm. to 2 cm. Microscopic examination of the esophagus (Fig. 8*B*) showed no tumor cells. Scarring and fibrosis were present.

In the lung, organizing bronchopneumonia with multiple abscess formation and no metastases were found.

Comment. The results of radiation therapy were very much better in this case than in Case I. Only occasional attacks of dysphagia occurred during a two year period. The patient was comfortable, gained weight, had no pain and ate quite

well during that period. He died thirty-four months after the beginning of the irradiation.

The gross anatomical and the histopathological changes in the thoracic esophagus as seen at the time of the autopsy were also much more favorable than in the previous case. Thickening of the esophageal wall,

Fig. 7. Case II. October 21, 1948. Photograph of the autopsy specimen shows obliteration of the mucosal folds in the treated area. No ulceration was noted.

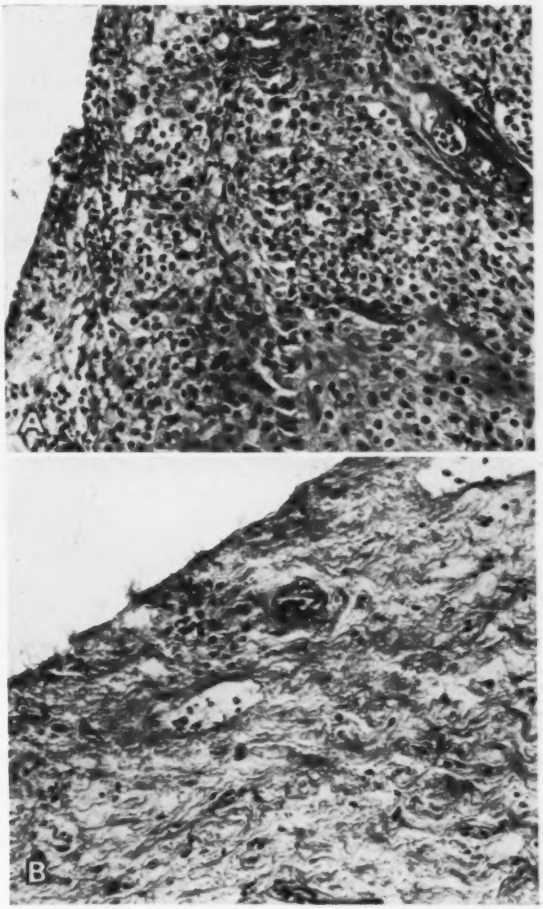

Fig. 8. Case II. (*A*) Photomicrograph, December 31, 1945. Squamous cell epithelioma, Grade 2. (*B*) October 21, 1948. Evidence of scarring and fibrosis. No tumor cells were found.

with only scarring and fibrosis, was found. No ulceration or significant thinning of the esophageal walls were present.

The results in these 2 cases with combined external and intracavitary irradiation encouraged us to utilize this method in another case. The review of the literature showed that this combined method has not been used frequently during the last decade.

Case III. G.M. The patient was a Japanese male, aged fifty-nine, who was first seen in the Department of Radiation Therapy at the White Memorial Hospital on September 9, 1948, with a history of dysphagia. The onset of the symptoms was approximately six to eight weeks before this date.

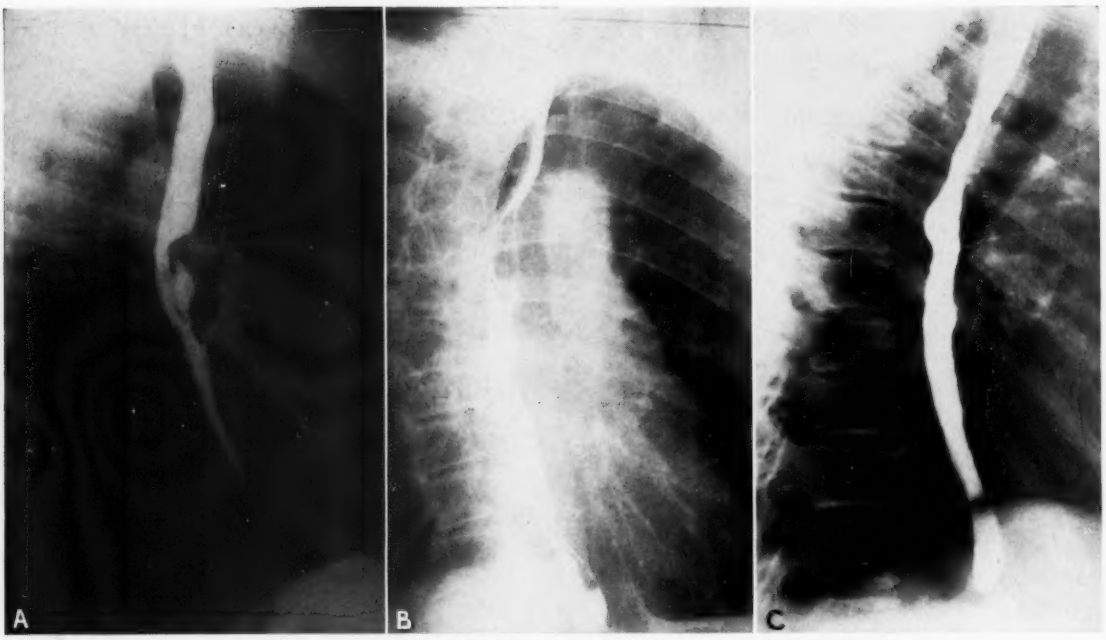

FIG. 9. Case III. (*A*) September 10, 1948. Ulcerated lesion measuring approximately 5 cm. in length and extending from the bifurcation downwards. (*B*) November 28, 1949. Complete disappearance of the ulceration. The walls of the esophagus are smooth and appear to be pliable on both roentgenographic and roentgenoscopic examinations. (*C*) June 2, 1950. The walls of the esophagus are well distended in the region of the lesion. The contrast material passed freely through the esophagus.

Roentgen examination showed an irregular filling defect of the middle third of the esophagus directly below the aortic arch (Fig. 9*A*). The lesion was approximately 5 cm. long. Esophagoscopy was performed on August 18, 1948, and at a distance of 20 cm. from the incisors, extending for a distance of 2.5 cm., there was a lesion with a white base which was edematous and attached to the anterior wall. The surface of the lesion was nodular and slightly eroded. Biopsy was taken.

It should be noted that the length of the lesion seemed to be shorter than on roentgen examination.

The pathological report (Fig. 10*A*) was squamous carcinoma of the esophagus, Grade 4. External radiation therapy was started on September 10, 1948. Three anterior and three posterior 6 by 16 cm. portals were used. The physical factors of the therapy were 200 kv., 1 mm. Cu plus 1 mm. Al filtration, utilizing a half-value layer of 1.5 mm. Cu, 20 ma., and 51.3 cm. distance. The patient received 200 r to each of two fields daily. After approximately 1,900 r was given the filtration was changed to 2 Thoraeus (0.41 mm. Sn, 0.26 mm. Cu, 0.98 mm. Al) giving a half-value layer of 2 mm. Cu. From September 10, 1948, to October 4, 1948, 2,500 r was given to the two anterior and posterior peripheral portals. The anterior central portal received 2,200 r and the posterior central portal received 1,600 r during this period. The calculated depth dose at the level of the lesion, using roentgenograms and the cross section chart of Eycleshymer and Shoemaker for measurement, was 5,550 r.

There was also one intraesophageal radium application on November 10, 1948, when a tandem with 6×25 mg. was given for four hours. The dosage was calculated in gamma roentgens and corresponded to 1,500 gamma roentgens at 1 cm. distance, utilizing Quimby's chart for linear source radium applicator. During the month following the radium application, the patient's chest pain, which appeared towards the end of the treatment, progressively disappeared, his appetite improved and his swallowing became very satisfactory.

Roentgen examination of November 28, 1949 (Fig. 9*B*) showed no definite evidence of tumor. A recheck esophagoscopy was done on January 5, 1950, and revealed no evidence of carcinoma. A biopsy was also obtained at that time (Fig. 10*B*). No tumor cells were seen.

Roentgen examinations were performed in January, September, and November, 1949, and also in June, 1950. In January the linear mucosal markings of the esophagus appeared to be obliterated in the region of the previous filling defect. However, there was no definite evidence of ulceration which would suggest the presence or recurrence of disease. On November 28, 1949, the esophagus showed slight narrowing in the area of previous irradiation. On June, 1950 (Fig. 9*C*) there was no stricture noted; the esophagus expanded with the passage of barium, and there was no evidence of loss of flexibility. The patient was last seen on August 10, 1950. He had no complaints and his appetite was excellent. He did not return for observation and inquiry revealed that he died suddenly in the street on October 17, 1950. The coroner's report was cardiac death, apparently due to coronary occlusion. No autopsy was performed.

REVIEW OF LITERATURE

It seemed to be worth while to review the literature and study the few available case reports of similar observations. The pathologically proved cases of sterilization of esophageal carcinoma by irradiation were reviewed. Good therapeutic results, *i.e.*, survivals of two years or over without evidence of recurrence, were also studied.

Palugyay,[11] in 1931, reported 32 cases of carcinoma of the esophagus treated with combined roentgen and radium therapy. Of the 23 who died, pathological study of 2 patients dead one and a half and one year after completion of therapy, failed to reveal metastatic or residual tumor. Only scar tissue was demonstrated. He also reported 2 cases of carcinoma of the lower third of the esophagus alive following radiation therapy. One case proved by biopsy was followed for four years; the treatment of the other unproved case was started eight years ago.

Crump and Kasabach[4] reported a case in 1935 of carcinoma of the upper third of the thoracic esophagus, who was autopsied nine months after intensive intraesophageal and external irradiation. No ulceration or tumor was present.

Baum,[1] in 1936, quotes Holfelder who in 1932 reported a patient, aged sixty-five, with epidermoid carcinoma of the esophagus dying from pneumonia five months after protracted radiation therapy. At autopsy the esophagus was completely healed. No ulceration was present. No tumor cells were demonstrated on histopathological examination. Baum reports a case of squamous cell carcinoma of the esophagus involving the cardiac end of the stomach treated with 200 kv. radiation (2 mm. Cu filter, 80 cm. distance); forty-two treatments were given in sixty-nine days. The patient remained cured for six years, with only slight irregularity of the cardiac end of the esophagus on roentgenoscopy.

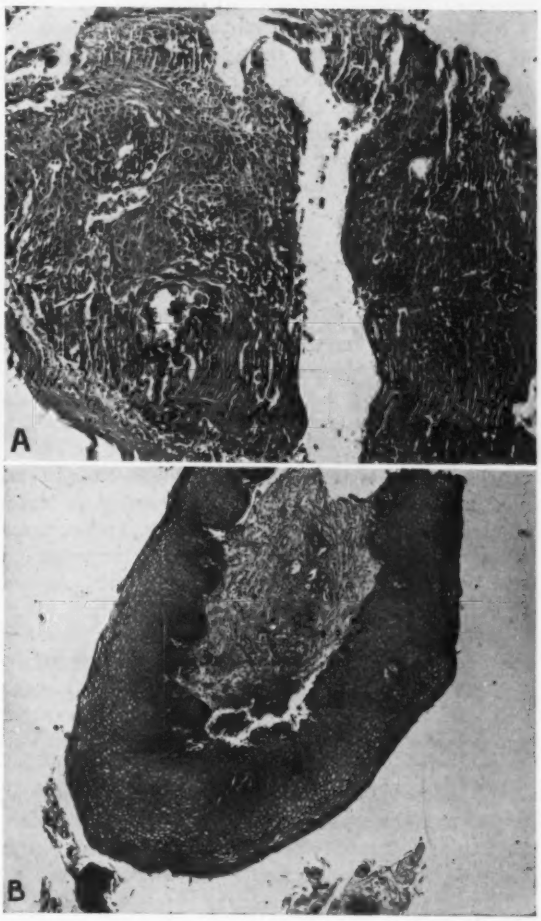

Fig. 10. Case III. (*A*) Photomicrograph, August 18, 1948. Dark staining, closely packed tumor cells with very small amount of stroma were demonstrated. *Diagnosis:* Squamous cell carcinoma, Grade 4. (*B*) January 5, 1950. Esophagoscopic biopsy showed no evidence of tumor cells. Layers of squamous epithelium are present.

Engelstad,[5] in 1939, had 1 patient come to autopsy without evidence of tumor (details of case were not given). He used combined roentgen and radium therapy during a period of eight to ten weeks. Of the 119 cases treated from 1932 to 1938, none lived over two years. Twelve died twelve to twenty-four months after the beginning of radiation therapy.

Strandqvist,[14] in 1941, reported 5 cases who at autopsy failed to demonstrate visible carcinoma. These 5 were among 18 patients who died one year following radical radiation therapy for carcinoma of the esophagus. Four of his patients were alive twenty-four, twenty-six, thirty months, and three years re-

spectively after completion of therapy.

Smithers[13] in 1943 reported 3 cases who were found at postmortem to have no sign of any residual primary tumor and no local ulceration. Four autopsied cases had local ulceration but no definite evidence of any viable cancer cells. Three out of 32 patients who completed treatment could be considered as cures. They were alive and symptom free for six years, four months; five years, one month; and four years, nine months respectively.

Lederman and Clarkson,[9] in 1945, reported 48 cases of tumors involving the upper third of the esophagus. They have obtained one to four year survivals in 15 cases. From 33 cases involving the middle third of the esophagus, only 1 patient survived two and a half years. Carefully controlled radium bougie treatment was used in these cases.

Phillips,[12] in 1944 treated 31 cases with 1,000 kv., of which 2 survived over two years, 4 over one year. The Holt Radiological Institute reported 90 cases treated with radical roentgen therapy. Two of these survived five years; 1 died with healed primary lesion and metastases, the other with late radiation changes of the lungs.

Jens Nielsen,[10] in 1945, reported 5 cases in which the patients died from distant metastases. No recurrence of the original tumor could be discovered, endoscopically or microscopically. In another 3 cases there was perforation at the site of the tumor without evidence of tumor tissue. Three other cases of carcinoma of the thoracic esophagus were reported in which the patients were well without evidence of tumor twenty-five, twenty-six and thirty months after completion of radiation therapy. These patients were treated with rotation therapy. He also reports in detail 5 cases of cervical esophageal cancer treated with protracted fractional therapy. Three of these were living and well at the time of the report for eleven, seven and a half and five and a half years respectively. The other 2 cases were autopsied four and five and a half years after completion of therapy without evidence of recurrence. The treatment was given with a half-value layer of 1.5 mm. Cu, 50–70 cm. distance, two to five portals, 50 to 125 $cm.^2$ in size. Total skin dose, 5,150 to 12,500 r in nineteen to fifty-six days.

Jacobsson,[7] in 1946, described the case of a male, aged fifty-eight, with carcinoma of the lower third of the esophagus. He received roentgen therapy with a tumor dose of 5,000 r over thirty-five days. Six years later he was still cured. Cardiac dilatation and pleural exudate have developed, probably secondary to irradiation.

Fleming,[6] in 1947, reviewed the results of radiation therapy in carcinoma of the esophagus. He quoted Pohle and Benson who, in 1943, reported 1 case of a seven year cure out of 85 cases of carcinoma in the upper third of the esophagus treated with a combination of radon seeds and three courses of external irradiation. He also quotes Smithers' statement that Guisez treated 270 cases with 3 surviving over five years, and 8 between three and four years. Guisez in 1937 stated that 1 patient is alive twenty-six years after treatment. Fleming's opinion is that "similar results have not been obtained by others using the same method."

Krebs, Nielsen and Andersen[8] reported the results of rotation therapy in 217 cases of carcinoma of the esophagus (1949); 111 patients received more than 10,000 r. In these, the average duration of life was ten months. Seven patients were alive at least seventeen months, 1 five years, ten months; four years, three months; twenty-eight, twenty-seven, twenty-six, seventeen and sixteen months respectively. The relation of location and life duration is shown in Table 1. In contrast with the few cures, excellent palliative effect was obtained. In 20 per cent there was complete disappearance on roentgen examination. In 35 per cent the dysphagia completely disappeared. In 62 per cent there was complete relief of pain. In 34 per cent there was considerable improvement in the general condition of the patient.

Buschke, Cantril and Parker,[3] in 1950, reported 6 cases who received a tumor dose of 4,400 to 7,300 r with 800 kv. One of these patients is well for six years (4,400 r) and another is well for twenty-seven months (4,950 r).

DISCUSSION

Both the review of the literature and the reports of these cases demonstrate the radiocurability of carcinoma of the esophagus.

The recent rapid advance of surgical treatment for carcinoma of the esophagus has had the unfortunate effect of placing

TABLE I

Duration of Life	1 Year	2 Years	3 Years	4 Years	5 Years
Upper third	20% 4/21	10% 2/21	0	0	0
Middle third	15% 10/65	6% 4/65	3% 2/65	3% 2/65	1.5% 1/65
Lower third	25% 19/77	0	8% 6/77	3% 2/77	0
Cardia	11% 6/54	0	0	0	0

radiotherapy in the background. We believe, however, that there remains a considerable place for radiation therapy in these lesions of the esophagus.

Any report of surgically treated cases of carcinoma of the esophagus demonstrates the large percentage of inoperable cases. Another group includes those cases in which only incomplete removal, palliative resection, can be done, while still another group of patients refuse surgery. In some cases there may be contraindication because of disease of other vital organs.

Radical radiation therapy with the intention of delivering cancerocidal doses of radiation should be attempted in all of these cases with much greater frequency. With the advent of supervoltage roentgen therapy and the perfection of rotation therapy, the technical problem of delivering a cancerocidal dose to carcinoma of the thoracic esophagus without injuring the adjacent vital organs has been simplified. However, the lack of availability of supervoltage therapy units and of rotation therapy equipment should not be considered an obstacle to achieving this aim. A tumor dose of between 4,500 and 6,000 r can be delivered with the conventional 200 kv. machine, 2 mm. copper or equivalent filtration, and utilizing six or more narrow and long portals. This can be particularly well achieved in the slender patient.

Theoretically it seemed advisable to add an intracavitary radium applicator in order to decrease the amount of the external irradiation and the dosage to the surrounding healthy tissues. The addition of radium from a linear source could successfully build up the tumor dose, especially in heavier patients or in patients who for various reasons do not tolerate extensive irradiation of the thorax.

The reported cases show that such combined treatment is quite well tolerated and it indicates that further research in evaluating such treatment might be fruitful.

An optimal ratio of the external and intracavitary irradiation may be worked out, possibly on the basis of two-thirds of the necessary tumor dose to be delivered by external and one-third by intracavitary irradiation.

SUMMARY

1. Two cases of carcinoma of the esophagus are reported in which autopsy after seventeen and thirty-four months respectively, following combined external and intracavitary radiation therapy failed to reveal residual tumor.

2. Another case with a survival of twenty-five months, in which the patient had no evidence of recurrence, clinically, roentgenologically, or by esophagoscopy and biopsy, is also reported. This patient died of heart disease, and no thorough autopsy was obtained.

3. A review of the literature covering the radiation sterilization and radiation curability of carcinoma of the esophagus is submitted.

4. The authors believe that radiation therapy of carcinoma of the esophagus should be used more frequently and radically in all cases where surgery cannot be used or where only incomplete surgery can be done. The negative attitude towards radiation therapy of cancer of the esophagus is not justified.

5. The combined external roentgen irradiation and intracavitary radium therapy of carcinoma of the esophagus needs further investigation for complete evaluation.

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OSSEOUS DAMAGE IN IRRADIATION OF RENAL TUMORS IN INFANCY AND CHILDHOOD*

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IT HAS long been recognized that the rapidly developing bones of young animals are particularly susceptible to damage by radiation, even in small doses. Systematic experimental studies were initiated soon after the advent of therapeutic irradiation, and the observation of Perthes (1903), Récamier and Tribondeau (1905–06) and Fösterling (1906) demonstrated the greater susceptibility of growing bone in contrast to adult bone, and showed that the disturbance in growth is greater, the younger the animal and the larger the dose of roentgen rays. A considerable volume of experimental work has been done on the effect of radiation on the growth of extremities; the choice of these sites is partially influenced by the accessibility of the extremities for accurate measurement and for subsequent histologic study. Similarly the clinical studies reported are mainly concerned with changes in extremity growth, with striking examples of growth disturbance reported by Haenisch,[7] Desjardins,[4] Stevens,[11] and more recently by Frantz.[6]

The vertebral column, probably because of its inaccessibility, has been less intensively studied; studies on the experimental production of scoliosis in animals have been completed by Engle using radium, and by Arkin and Simon using radon and roentgen rays. The clinical appearance of vertebral damage, scoliosis and unilateral underdevelopment of the ilium following irradiation of Wilms' tumor in infancy was first reported by Arkin *et al.* in April, 1950.[1,2,3,5,8]

Vertebral damage and unilateral underdevelopment of the ilium have been demonstrated in 4 patients at the University Hospital who have survived ten years or more following irradiation in infancy and childhood for renal tumors. Variations in the treatment program in effect at the different times of admission of the patients provided an opportunity to evaluate in a general way the factors in dosage contributing to the severity of the vertebral bone damage and the resultant scoliosis. These cases are summarized as follows: (Note: All irradiation was carried out at 200 kv., 25 ma., 50 cm. target skin distance, filtration of 0.5 mm. Cu and 1 mm. Al, half-value layer 0.9 mm. Cu, and stated doses measured in air.)

REPORT OF CASES

CASE 1. Female, aged three years (No. 317795). Admitted March 5, 1935.

This patient had previously been seen at the hospital for hydrocephalus and a hemangioma of the left chest. Four weeks prior to this admission she developed marked abdominal distention and a mass was noted in the right flank. At the time of admission, examination showed a poorly nourished child of below average mentality. There was impaired resonance in the right chest and a nodular mass was found in the right abdomen extending below the umbilicus. A biopsy specimen obtained by kidney puncture was reported as follows: "Chiefly blood clot in which there are small fragments of malignant neoplasm. While the amount of material is scant, the evidence available indicates that this is a very malignant Wilms' tumor (adenorhabdomyosarcoma)." Dr. C. V. Weller.

Roentgenograms confirmed the presence of a right renal mass and right pleural effusion and showed no abnormality of the spine or pelvis (Fig. 1*A*). Irradiation was started to anterior and posterior right abdominal fields (15 by 10 cm. in size), 185 roentgens being administered to each of the two fields each day with a total of 1,850 r to each field in thirteen days. The abdominal tumor decreased to one-half its original size. Microscopic blood was found in pleural fluid taken from the right chest, and the possibility of pulmonary metastases was considered but not proved. The prognosis was thought to

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be hopeless and the patient discharged without nephrectomy or irradiation to the chest.

The patient returned for a check-up on August 25, 1939, at which time no abdominal mass was found. Equinovarus deformity of both feet was present. The spine was straight on clinical examination but no roentgenograms were obtained. No films were obtained during a subsequent visit in August, 1943.

She was next seen at an outpatient clinic elsewhere on October 23, 1945, at which time a definite left lumbar structural scoliosis was found and further study at the University Hospital was advised. Roentgenograms made on

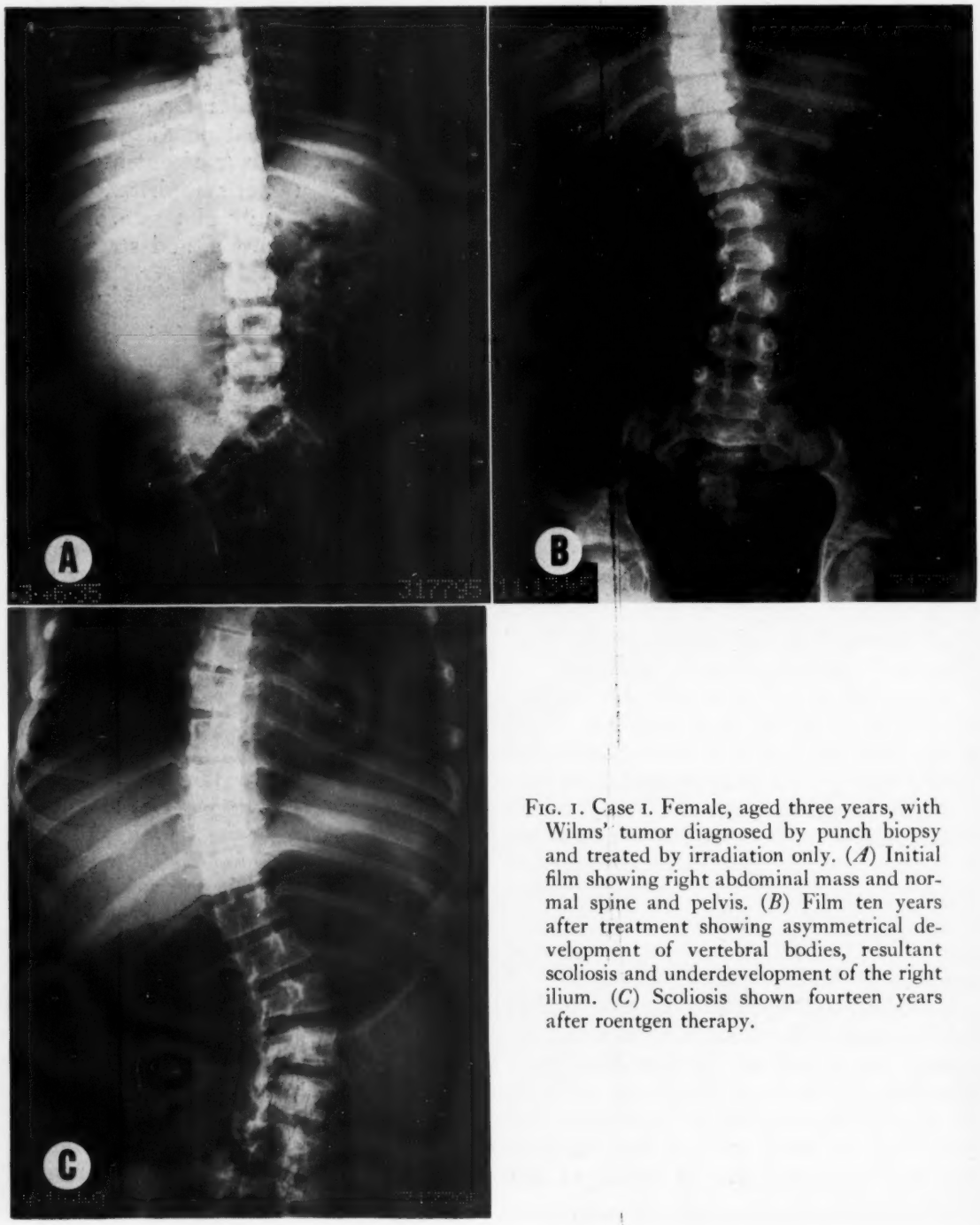

FIG. 1. Case 1. Female, aged three years, with Wilms' tumor diagnosed by punch biopsy and treated by irradiation only. (*A*) Initial film showing right abdominal mass and normal spine and pelvis. (*B*) Film ten years after treatment showing asymmetrical development of vertebral bodies, resultant scoliosis and underdevelopment of the right ilium. (*C*) Scoliosis shown fourteen years after roentgen therapy.

November 15, 1945, confirmed the left lumbar scoliosis from D-11 to L-5 (Fig. 1*B*). There is asymmetry of the lumbar vertebral bodies, with retarded growth in the right lateral portions. They are also smaller in height than one would expect in comparison with the thoracic vertebral bodies. There is associated underdevelopment of the right ilium. The patient was subsequently treated by Risser cast therapy for the scoliosis and operative procedures for talipes equinovarus. The most recent roentgenogram of the spine taken on April 14, 1949, shows the scoliosis essentially unchanged (Fig. 1*C*).

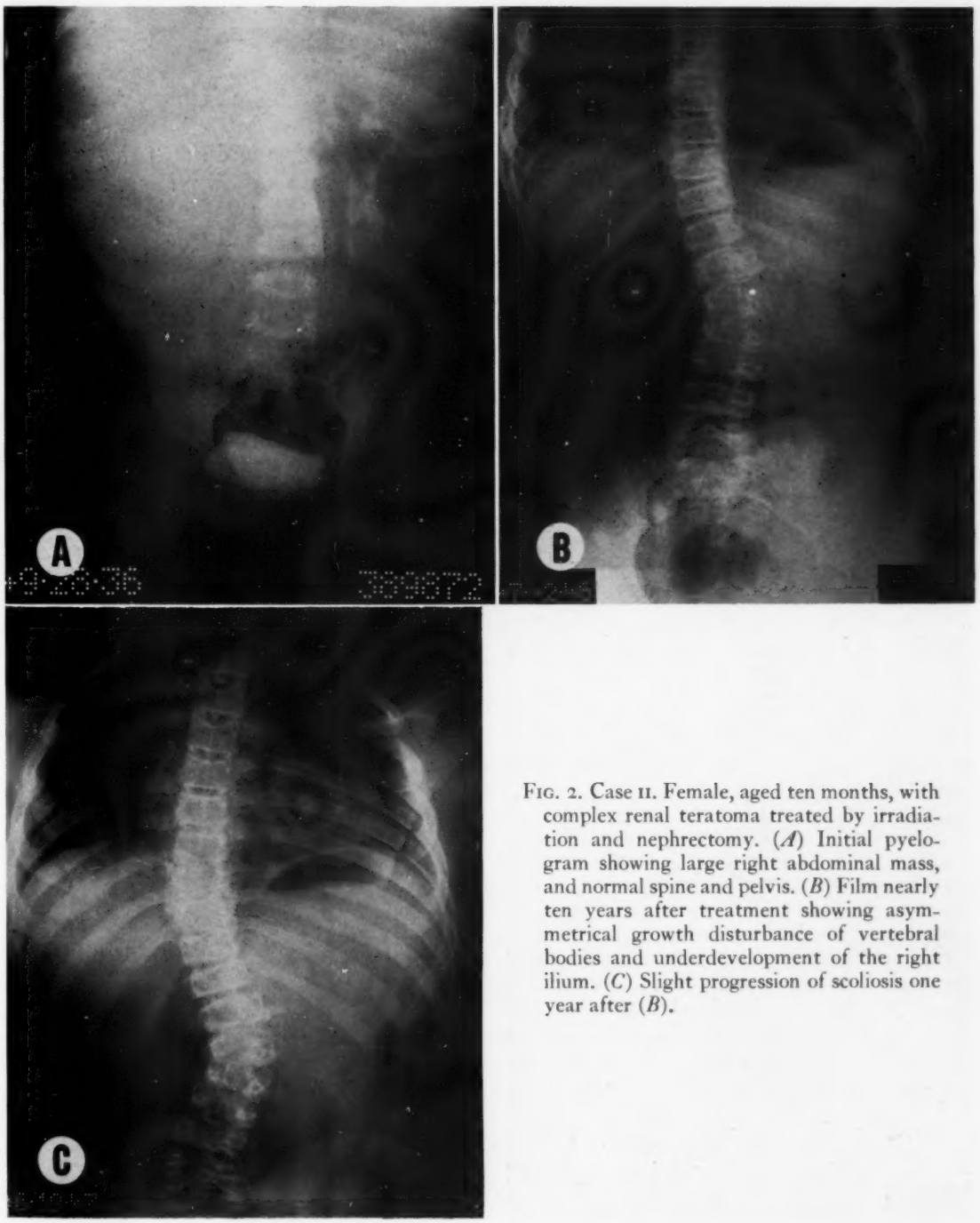

Fig. 2. Case 11. Female, aged ten months, with complex renal teratoma treated by irradiation and nephrectomy. (*A*) Initial pyelogram showing large right abdominal mass, and normal spine and pelvis. (*B*) Film nearly ten years after treatment showing asymmetrical growth disturbance of vertebral bodies and underdevelopment of the right ilium. (*C*) Slight progression of scoliosis one year after (*B*).

CASE II. Female, aged ten months (No. 389872). Admitted September 24, 1936.

Two weeks prior to admission a tumor was noted in right abdomen. At admission it was about the size of a fist, firm, and slightly lobulated. Films showed the abdominal tumor and also showed a normal spine and pelvis (Fig. 2*A*). Preoperative irradiation was carried out with anterior, lateral and posterior right abdominal fields 20 by 8 cm. Two hundred roentgens was given to one field daily, with a total dose of 2,600 r to each of the anterior and posterior fields and 400 r to the lateral field in thirty-five days. The tumor showed considerable reduction in size and the patient returned for nephrectomy on December 30, 1936, at which time complete

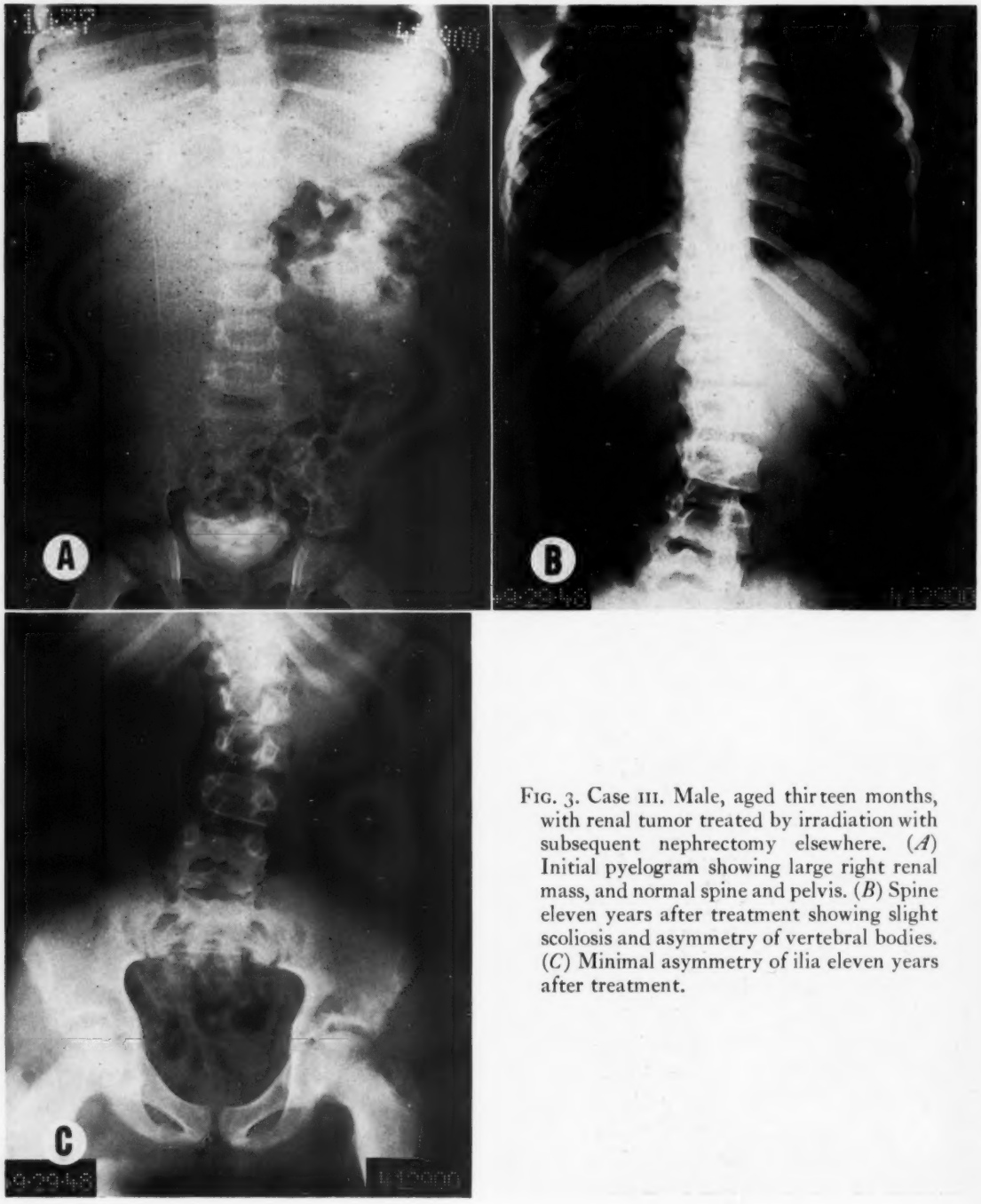

FIG. 3. Case III. Male, aged thirteen months, with renal tumor treated by irradiation with subsequent nephrectomy elsewhere. (*A*) Initial pyelogram showing large right renal mass, and normal spine and pelvis. (*B*) Spine eleven years after treatment showing slight scoliosis and asymmetry of vertebral bodies. (*C*) Minimal asymmetry of ilia eleven years after treatment.

removal was done. The pathology report showed a complex teratoma with extensive necrosis, "appearing to be benign so far as living elements are concerned; impossible to determine whether the necrotic granular areas contained more malignant neoplasm than that which survives." Dr. R. C. Wanstrom.

The patient was next seen on July 2, 1946, at the age of ten and a half, for her scoliosis, which was said to have been present for three years.

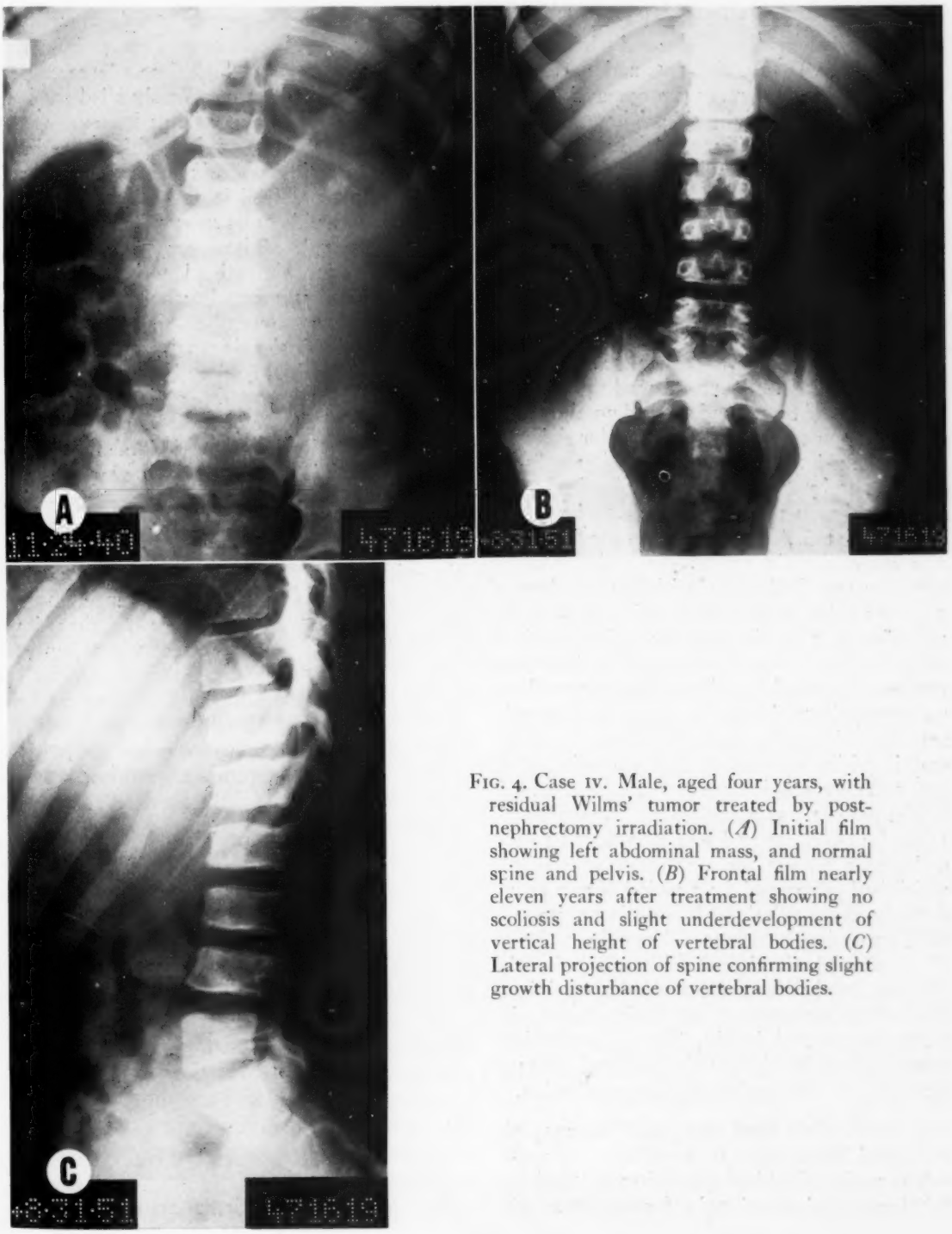

Fig. 4. Case IV. Male, aged four years, with residual Wilms' tumor treated by post-nephrectomy irradiation. (*A*) Initial film showing left abdominal mass, and normal spine and pelvis. (*B*) Frontal film nearly eleven years after treatment showing no scoliosis and slight underdevelopment of vertical height of vertebral bodies. (*C*) Lateral projection of spine confirming slight growth disturbance of vertebral bodies.

Examination showed a left lumbar scoliosis with apparent pelvic obliquity but equal leg length. Films (Fig. 2*B*) confirmed the left lumbar scoliosis and in addition showed evidence of a profound disturbance of growth of the vertebral bodies. They are of decreased density with a coarse trabecular pattern and are decreased in vertical height when compared with the dorsal vertebrae. D-12 and L-1, 2, and 3 are asymmetrical with the more pronounced growth limitation on the right side. There is underdevelopment of the ilium on the right. A film on June 19, 1947, shows slight progression of the scoliosis (Fig. 2*C*).

CASE III. Male, aged thirteen months (No. 412900). Admitted November 5, 1937.

About one month prior to admission a mass was noted in the right abdomen which became progressively larger. At the time of admission it extended from the lower rib margin to the crest of the ilium. Films confirmed the presence of a right renal tumor and showed no abnormality of the spine (Fig. 3*A*). An anterior right abdominal field 12 by 10 cm., subsequently reduced to 10 by 8 cm. and a posterior field 10 by 9 cm., subsequently reduced to 10 by 8 cm. were irradiated. A dose of 300 r to one field daily was given for six treatments and thereafter 200 r to one field daily, with a total dose of 1,700 r to the anterior field and 1,900 r to the posterior field in nineteen days, during which time the tumor decreased in size. Nephrectomy was recommended but the mother removed the patient against advice. Nephrectomy was subsequently done elsewhere on March 22, 1938, and inquiries concerning the operative findings and microscopic report remain unanswered.

The patient was next seen on September 28, 1948, for check-up and was transferred to the orthopedic service for treatment of scoliosis which had progressed for a period of two years. A left lumbar scoliosis with lordosis was present with a rotational element. Films (Fig. 3, *B* and *C*) confirmed the left lumbar scoliosis; the changes in the vertebral bodies are minimal with slight asymmetry and little, if any, decrease in vertical height. The underdevelopment of the right ilium is also minimal. The patient has not returned for further evaluation.

CASE IV. Male, aged four years (No. 471619). Admitted November 24, 1940.

The patient had had intermittent attacks of left lower abdominal pain for one year, the last attack recurring two days prior to admission, at which time a mass was noted in the left abdomen. On admission the mass was estimated to be approximately 6 by 9 inches, extending from the costal margin to the iliac crest. Films confirmed the abdominal mass and showed no abnormality of the spine or pelvis (Fig. 4*A*). Left nephrectomy was done on December 4, 1940, at which time a large grapefruit size mass almost completely filled the left flank. It was adherent to the peritoneum anteriorly and was dissected free with some difficulty. Metastatic neoplastic nodes were present around the renal pedicle and adjacent to the aorta; these could not be removed. The nephrectomy was completed, however. Histopathological examination showed adenorhabdomyosarcoma—Wilms' tumor. Postoperative irradiation was begun December 16, 1940, with an anterior abdominal field 12 by 10 cm. and a posterior abdominal field 12 by 10 cm., with a daily dose of 150–200 r per day to only one field and total dosage of 2,300 r anteriorly and 2,350 r posteriorly in a period of thirty-two days. The child was subsequently seen at regular intervals until the age of ten and remained well. During this time chest roentgenograms showed no abnormality and no abnormality of the spine was noted clinically.

The patient was not seen again until August 31, 1951, at the age of fourteen. At that time no scoliosis was present. There was a lumbar lordosis evident clinically. Roentgenograms of the spine (Fig. 4, *B* and *C*) also show no evidence of scoliosis. There is, however, underdevelopment of the lumbar vertebral bodies with a decrease in height compared to the thoracic vertebrae. There is slight underdevelopment of the left ilium.

DISCUSSION

For more direct comparison, the field size, daily dose, total dose and duration of treatment are found in Table 1.

By comparison of the roentgenograms made a decade following completion of therapy, it is seen that the vertebral bone damage and scoliosis are most severe in Cases I and II, less severe in Case III, with Case IV showing no scoliosis and less severe vertebral body damage.

Estimation of the intensity of radiation

TABLE I

Case	Age	Field	Size cm.	Total Dose	Daily Dose	Duration of Treatment
I	3 yr.	Ant. rt. abdomen Post. rt. abdomen	15×10 15×10	1,850 r 1,850 r	185 r to each of 2 fields	13 days
II	10 mo.	Ant. rt. abdomen Post. rt. abdomen Lat. rt. abdomen	20× 8 20× 8 20× 8	2,600 r 2,600 r 400 r	200 r to 1 field daily	35 days
III	13 mo.	Ant. rt. abdomen Post. rt. abdomen	12×10 10× 8 10× 9 10× 8	1,900 r 1,700 r	300 r to 1 field daily for first 6 treatments; 200 r to 1 field daily for 9 treatments	19 days
IV	4 yr.	Ant. lt. abdomen Post. lt. abdomen	12×10 12×10	2,300 r 2,350 r	150–200 r to 1 field daily	32 days

effect in terms of ionization quantity delivered to the vertebrae and ilia qualified by the parameter of degree of protraction of the treatment would be desirable. The nonavailability of physical dimensions of the patient, the unsuitability of standard depth dose tables because the pertinent osseous structures were not in the path of the central axes of the roentgen-ray beams, the distortions of depth dose and isodose curves produced by the elongation factor of the fields and the absence of satisfactory data on effect of bone on 200 kv. radiation depth doses and isodose curves make determination of ionization quantity in the bony structures impossible. However, a general estimate of relative intensity of the radiation effect can be achieved by a consideration of the magnitude of field size, daily air dose, total air dose and extent of protraction.

The most intense irradiation is found in Case I by virtue of the short duration of the treatment (thirteen days), the irradiation of two fields daily and the high daily dose (370 r). The next most intensive irradiation is found in Case II as judged on the basis of the large fields (20 by 8 cm.); the age of the patient, ten months, which may be considered an indicator of patient size, and the relatively high total dosage (2,600 r to each of two fields, and 400 to a third). These factors tend to result in a relatively intense radiation effect which is only partially attenuated by the protraction to thirty-five days. Third in order ranks Case III because of the initial high daily dose (300 r) which reduced the extent of protraction to nineteen days. The least intense irradiation is shown in Case IV with reasonable field size (12 by 10 cm.), lower daily dose (150–200 r) with adequate protraction to thirty-two days and a total dose which is not excessive.

The listing of the cases in order of these general estimates of decreasing intensity of irradiation, then, is the same as the order of decreasing degree of vertebral damage and associated scoliosis. It appears, therefore, that appropriate adjustment of dosage factors leading to a decrease in intensity of irradiation is followed by a decrease in the resultant vertebral damage.

It is evident from this comparison that, in treating renal tumors in infancy, as has been amply demonstrated in treating certain neoplastic lesions in other locations and in older age groups, the neighboring normal structures are best protected by using as small a field as feasible, using relatively small daily doses with adequate protraction, and avoiding excessive total dosage. This protection of normal structures is doubly important in these cases because of

the susceptibility of growing bone to radiation.

The problem of avoiding excessive damage to normal structures then becomes one of determining the level to which the radiation intensity can be reduced and yet continue to control the tumor effectively. Evidence bearing on this problem as applied to Wilms' tumor is found in Cases I and IV. These have been included in material previously reported from the University Hospital by Nesbit and Adams.[9] In Case I no surgery was employed except a kidney puncture for biopsy purposes. The radiation was administered relatively intensely, treating two fields daily and delivering 1,850 r to each of the two fields in thirteen days. The Wilms' tumor was cured by irradiation alone, with a known survival of fourteen years and seven months. This cure, however, was accompanied by severe vertebral damage and scoliosis. In contrast, in Case IV grossly metastatic neoplastic nodes were left behind in the region of the renal pedicle at the time of nephrectomy. (It was felt unwise to biopsy them for microscopic proof, which would have been of further value in this discussion.) Postoperative irradiation thus appears to have contributed to the cure and subsequent survival to date of eleven years and nine months. The radiation in this case, however, was administered less intensively and the resulting bone damage is of little or no clinical significance.

It is apparent that both treatment programs were successful in eradicating the Wilms' tumor, and that the reduction in intensity of irradiation in Case IV was apparently still within the limits of effective tumor treatment. One must be reserved in accepting the result in Case IV as a cure by irradiation because of the lack of histopathological proof concerning the residual neoplasm remaining after nephrectomy, although we are confident that residual neoplasm did exist because of the gross findings at operation. Another factor to be considered is that within the group of Wilms' tumors, there is undoubtedly a variation in the individual lethal dose. What may have proved to be adequate for this particular tumor residuum might not be adequate for another case. Hence it should not be inferred that this radiation dosage level might apply to Wilms' tumor generally. The results do indicate, however, an interesting correlation between the intensity of irradiation and the degree of bone damage.

As Desjardins emphasized in his discussion on bone damage in therapeutic irradiation, the purpose in calling attention to it is not to deter the therapist, but to recognize realistically all of the eventual effects of treatment. By individualizing the therapy within the limits of effective tumor treatment, it may be possible to minimize such late effects. With the growing number of long-term survivals following preoperative or postoperative irradiation for renal tumors in infancy and childhood, it will eventually be possible to correlate bone damage and dosage factors more accurately than this small group of cases permits. This review does, however, serve to call attention to the problem and to indicate some of the factors involved.

SUMMARY

1. Four patients surviving ten years or more following irradiation for renal tumors in infancy or childhood demonstrated vertebral damage and unilateral underdevelopment of the ilium of varying degree.

2. The degree of bone damage appears to be related to factors in dosage; adequate protraction with small daily doses, smaller field size, and lower total dosage lead to diminution of eventual bone damage.

3. The problem of avoiding excessive damage becomes one of determining the level to which the radiation intensity can be reduced within the limits of effective tumor treatment.

4. An inoperable proved case of Wilms' tumor survived following an intensive course of irradiation with resultant severe vertebral damage and scoliosis.

5. A postoperative case of Wilms'

tumor with apparent residual neoplasm survived following protracted irradiation with resultant minimal vertebral damage and no scoliosis; the change in dosage factors were apparently still within the limits of effective tumor treatment in this case.

6. Further evaluation of this problem is suggested by correlating data on bone damage in the increasing number of long term survivals following irradiation for renal tumors in infancy and childhood.

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ADDENDUM

Following the completion of this study, our attention was drawn to the paper of Neuhauser and Wittenborg[10] presented at the meeting of the Radiological Society of North America in December, 1951. Their work demonstrated vertebral body changes in 21 of 34 treated cases followed for varying lengths of time, with changes varying from the presence of growth disturbance lines in the vertebral bodies to gross disturbance of vertebral contours. The younger patients were found more susceptible and the calculation of tumor dose to the vertebral body demonstrated a rough correlation with the vertebral body changes.

We have found the calculation of tumor dose to an area at the edge of, or just outside of, a field of irradiation somewhat difficult from present depth dose tables, as indicated above, especially for 200 kv. radiation where bony structures are involved. In addition, tumor dose calculation does not take into consideration the time factor, which we believe to be an important one in an estimation of the intensity of irradiation, as indicated by the severe bone changes in Case 1 with a relatively small total dose delivered in a relatively short period of time. The suggestion of these authors for decreasing the incidence of scoliosis by including the entire width of the spine in the irradiated field if any of it is to be included is interesting, but such a procedure would add to the size of the fields and still would not guarantee a uniform irradiation to both sides of the vertebral epiphysis, situated as it is at the edge of the irradiated field.

Their study provides the largest collection of data yet available for the continued study of the effect of radiation on the growing spine.

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RADIUM PROTECTION*

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THERE has been an increase in the use of radium and other radioactive materials during the last few years. At the same time research has improved our knowledge of the biologic effects of radiation, and has provided us with more information about permissible dosage levels for personnel working with radioactive materials. In 1950, the International Commission on Radiological Protection recommended that for whole body irradiation for personnel exposed over an indefinite period to roentgen or gamma radiation, the maximal permissible dose should be 0.3 roentgen per week. In the case of exposure of the hands and forearms, the maximal permissible dose should be 1.5 roentgens per week.

The use of radioactive isotopes is of recent origin, and has matured under a strict program of protection consciousness. Radium therapy, however, has developed haphazardly so far as protection is concerned. Several years ago we instituted a program of radiation measurement at the Mayo Clinic. It soon became apparent that the physicians and nurses and members of the radiation physics division who handle radium were receiving doses bordering on, and sometimes in excess of, the permissible levels then in effect, namely, 1 roentgen per week. As a result we began a long-range program of modification and improvement of procedures and of radium applicators which has effected a reduction in exposure, so that now our personnel seldom exceed the current permissible dose level, even though the patient load has risen. We shall describe briefly a few of these improvements, because many of the principles can be applied toward re-

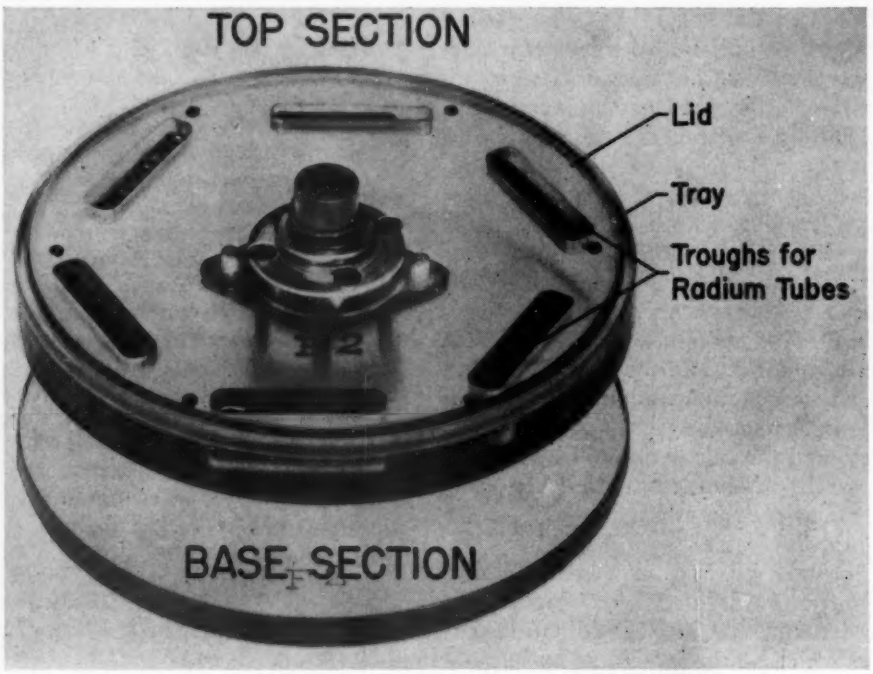


FIG. 1. External radium applicator.

* Presented at the Thirty-fourth Annual Meeting, American Radium Society, Chicago, Illinois, June 8–10, 1952.

TABLE I

APPLICATORS FOR EXTERNAL RADIUM THERAPY: SPECIFICATIONS

Applicator	Radium-Skin Distance, cm.	Dimensions of Base Section, cm.	Number of Radium Sources*	Arrangement of Radium Sources	Separation of Active Sources, cm.	
					Between ends	Between rows
2.5 cm., 4 tube, square	2.5	7.0× 7.0	4	2 parallel rows of 2 tubes each	2.5	3.5
2.5 cm., 6 tube, circular	2.5	Diameter =7.8	6	Single circle	1.8	Diameter =5.8
2.5 cm., 2 tube, linear	2.5	3.5× 7.0	2	Linear	2.5	
2.5 cm., 3 tube, linear	2.5	3.5×10.5	3	Linear	2.5	
2.5 cm., 4 tube, linear	2.5	3.5×14.0	4	Linear	2.5	
5.0 cm., 4 tube, point-source†	5.0	7.0× 7.0	4	Side by side	None	None

* Active length of radium sources, 1.2 cm.
† Over-all active area 1.2×1.4 cm. May be considered a point-source at 5.0 cm. distance.

duction of exposure in any radium therapy department even though details of procedure may necessarily vary.

A number of applicators have been devised for use in external radium therapy. They are versatile in their adaptability for treatment of lesions of various sizes and shapes. These applicators can be loaded, applied and disassembled easily and with minimal radiation hazard to the operator. The applicators are constructed primarily of lucite (Fig. 1) and consist of a detachable base section which contains no radium, and a radium-containing top section, which at the appropriate time may be attached to the base section on the patient. The top section, which may be circular, rectangular or square, is essentially a tray with troughs to hold the radium tubes and a lid that fits over it. The base section, which also may be circular, rectangular or square, has a central projection to receive the top section, and is that portion of the applicator which is applied to the patient at leisure prior to attachment of the loaded top section. Specifications for these applicators are given in Table 1. The steps of loading and application are illustrated in Figure 2. On completion of treatment, the applicator is removed from the patient and disassembled in a similar manner, except that the steps are reversed.

Figure 3 shows the 2.5 cm., six tube, circular applicator being employed for treatment of skin carcinoma. This applicator is useful for treating superficial lesions which are less than 6 cm. in diameter. It may also be used to supplement interstitial radium therapy. Dosage may be determined from the Paterson-Parker charts for surface applicators.

The 2.5 cm., four tube, square applicator (Fig. 4) is used primarily to treat large superficial lesions, often supplemental to interstitial radium therapy. The total area to be treated is marked off into areas of 7 by 7 cm., and the applicator is applied to each area in succession. The entire treatment area is thus covered by multiple parallel rows of radium tubes. The most

FIG. 2. Steps in the loading and application of the external applicators: (*a*) the top section is placed on a special holding pedestal by means of a right-angled handle, (*b*) and is locked in place by turning the locking knob on the right-angled handle; (*c*) the lid of the top section is removed from the tray with the lid handle; (*d*) radium tubes are placed in the tray; (*e*) the lid is replaced on the tray; (*f*) the loaded top section is removed from the pedestal by means of the right-angled handle, (*g*) and is placed in lead-lined carrier; (*h*) in the meantime the base section is applied to the patient; (*i*) the loaded top section is removed from the carrier by means of a straight handle, (*j*) and is attached to the base section.

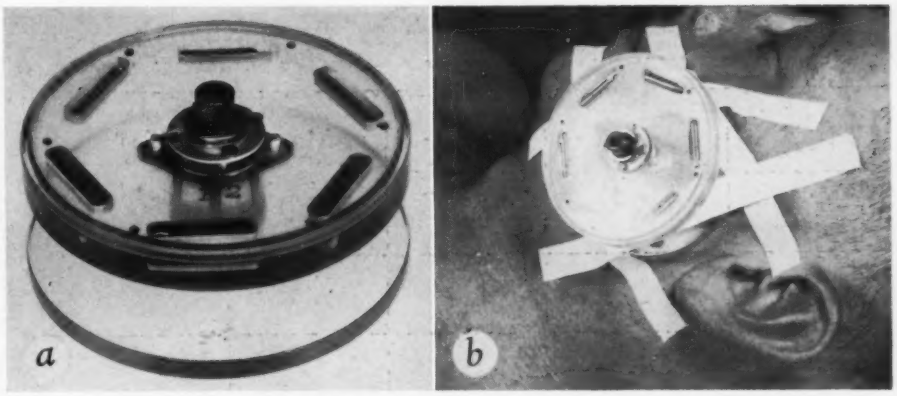


Fig. 3. (*a*) The 2.5 cm., six tube, circular applicator. (*b*) The applicator being employed for treatment of skin carcinoma.

peripheral radium tubes should extend well beyond the borders of the lesion. Dosage can be determined from tables prepared especially for these applicators (Tables II to VI) or from the Paterson-Parker charts for surface applicators.*

The 5 cm., point-source applicator (Fig. 5) is designed primarily for treating deeper lesions, such as brain tumors, particularly in young children. An adequate tumor dose can be delivered by treating over multiple ports so as to cross-fire the lesion. Usually a single area is treated at a time. Since this applicator may be considered a point-source at a distance of 5 cm. or more, dosage can be calculated by utilizing the point-source law and the inverse-square formula.

Applicators of the linear type (Fig. 6) are designed to hold two, three or four radium tubes. They are employed for therapy under varying circumstances, either alone or in combination with other

* The average dose may be determined from the Paterson-Parker charts if the active area is figured as the area encompassed by the centers of the most peripheral radium tubes for the entire treatment area.

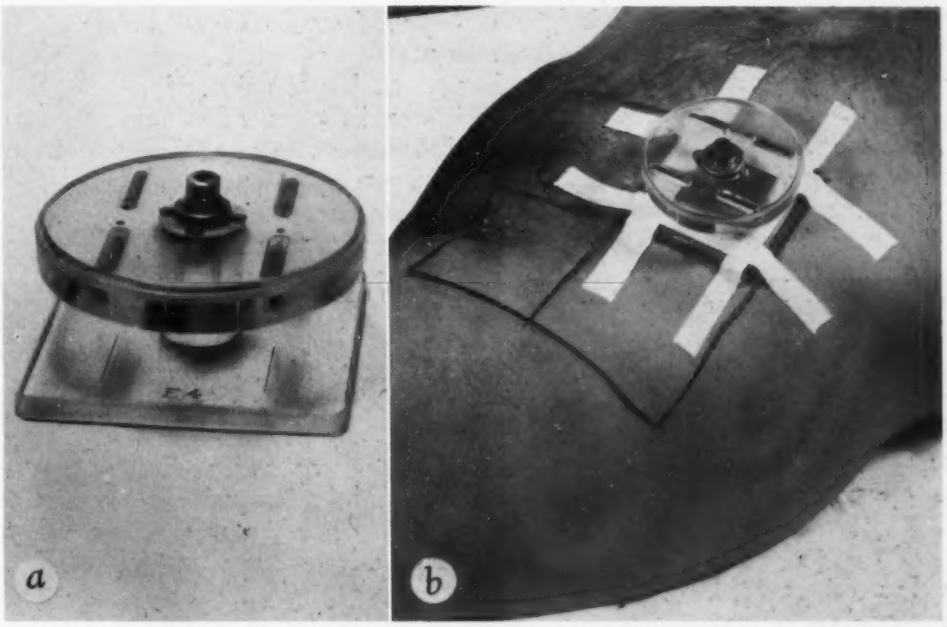


Fig. 4. (*a*) The 2.5 cm., four tube, square applicator. (*b*) The applicator being employed for treatment of inguinal lymph nodes.

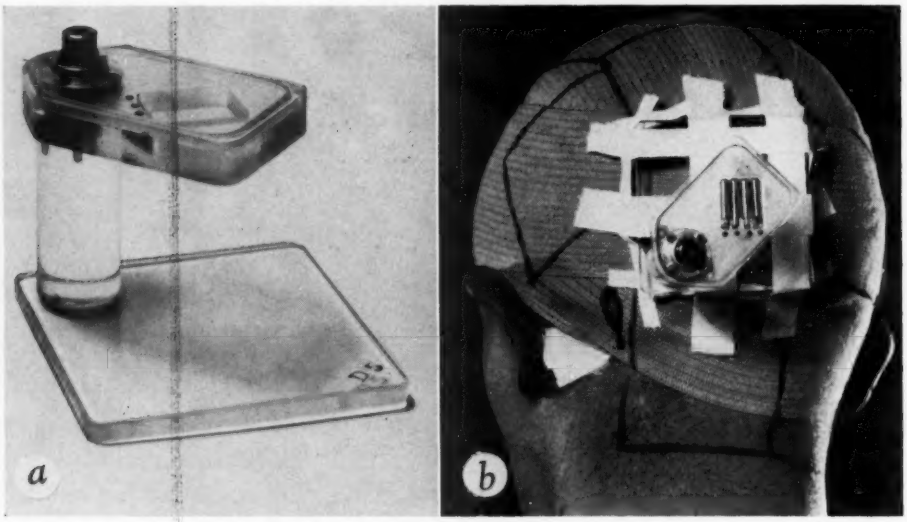


Fig. 5. (*a*) The 5 cm., four tube, point-source applicator. (*b*) The applicator being employed to treat a brain tumor.

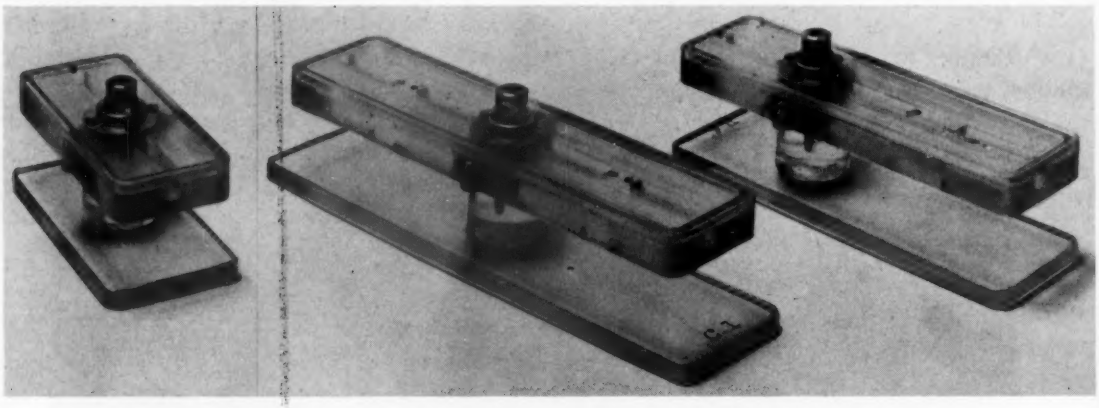


Fig. 6. The 2.5 cm., two, four and three tube (left to right), linear applicators.

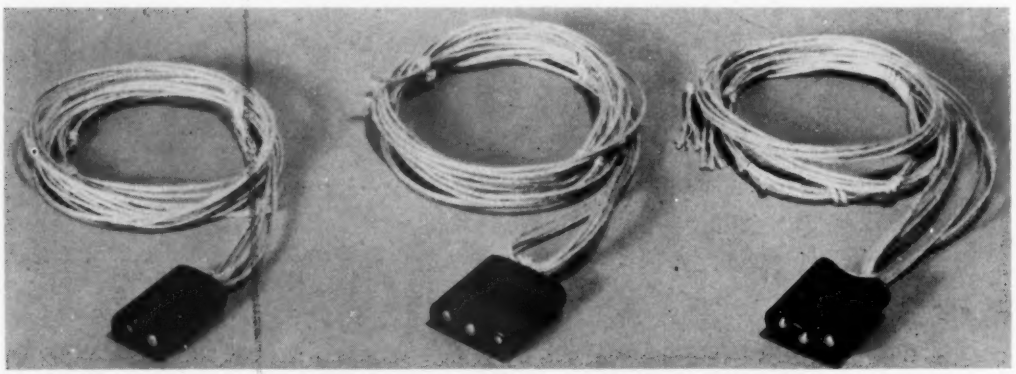
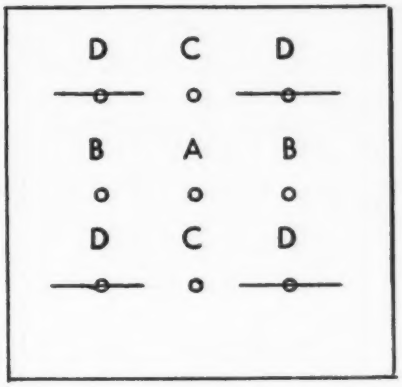


Fig. 7. The multiple-tube plaque applicators.

TABLE II

DOSAGE TABLE

The 2.5 cm., Four Tube Square Applicator
(Treatment administered to one area)



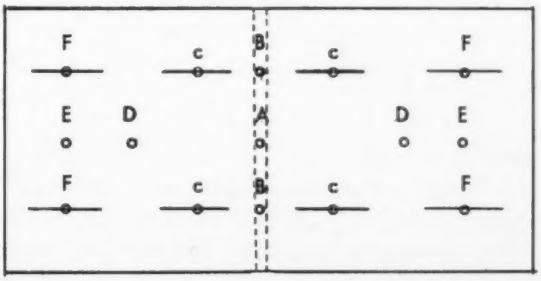
ROENTGENS PER 100 MILLIGRAM HOURS DELIVERED AT VARIOUS DISTANCES

Dosage Points	Distance in Centimeters													
	2.5 (Skin surface)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0
A	55.2	46.4	38.5	32.2	27.3	23.4	20.1	17.3	15.2	13.4	12.3	10.6	8.6	7.0
B	52.8	43.2	35.6	29.7	25.1	21.5	18.6	16.3	14.3	12.7	11.4	10.2	8.3	6.8
C	52.1	43.2	36.0	30.2	25.6	22.0	19.0	16.6	14.6	12.9	11.5	10.3	8.3	6.9
D	52.0	40.9	33.1	27.8	23.6	20.4	17.7	15.5	13.7	12.2	10.9	9.3	8.0	6.6

TABLE III

DOSAGE TABLE

The 2.5 cm., Four Tube Square Applicator
(Treatment administered to two adjacent areas)



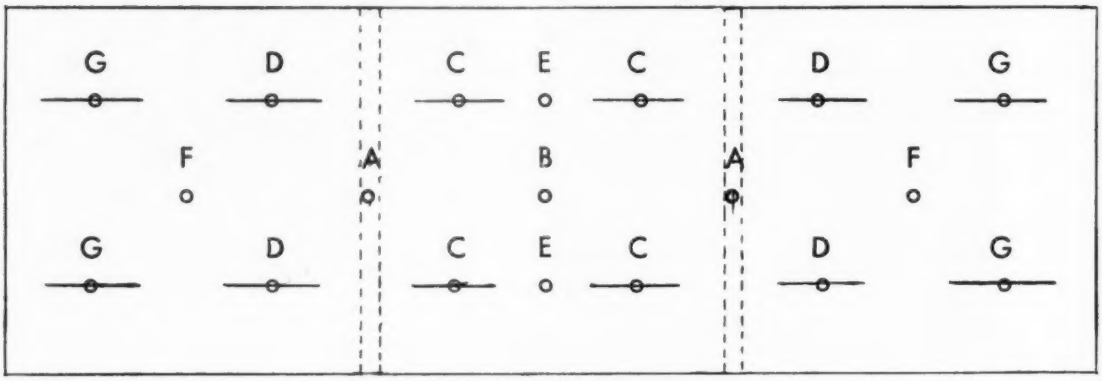
ROENTGENS PER 100 MILLIGRAM HOURS DELIVERED AT VARIOUS DISTANCES

Dosage Points	Distance in Centimeters													
	2.5 (Skin surface)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0
A	40.1	33.9	28.8	24.7	21.3	18.5	16.1	14.2	12.7	11.3	10.3	9.2	7.6	6.4
B	38.3	31.8	27.0	23.1	19.9	17.4	15.3	13.6	12.1	10.9	9.8	8.9	7.4	6.2
C	37.3	30.8	25.9	22.4	19.4	17.1	15.1	13.4	12.0	10.8	9.7	8.8	7.3	6.1
D	34.4	29.7	25.5	22.0	19.1	16.8	14.8	13.0	11.7	10.5	9.7	8.6	7.2	6.0
E	30.3	25.5	21.6	18.6	16.2	14.2	12.6	11.3	10.2	9.2	8.4	7.7	6.4	5.5
F	29.8	24.2	20.3	17.5	15.3	13.6	12.1	10.9	9.8	8.9	8.1	7.4	6.3	5.3

TABLE IV

DOSAGE TABLE

The 2.5 cm., Four Tube Square Applicator
(Treatment administered to three adjacent areas)



ROENTGENS PER 100 MILLIGRAM HOURS DELIVERED AT VARIOUS DISTANCES

Dosage Points	Distance in Centimeters													
	2.5 (Skin surface)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0
A	29.0	24.8	21.4	18.6	16.2	14.3	12.6	11.2	10.2	9.1	8.4	7.6	6.4	5.5
B	27.4	24.1	21.1	18.5	16.4	14.6	13.0	11.6	10.5	9.5	8.8	7.9	6.7	5.7
C	27.4	23.0	19.7	17.3	15.3	13.6	12.2	11.0	10.0	9.0	8.2	7.5	6.4	5.4
D	26.6	22.2	18.9	16.4	14.5	12.9	11.5	10.3	9.4	8.5	7.7	7.1	6.0	5.1
E	25.9	22.7	19.9	17.5	15.5	13.9	12.4	11.2	10.1	9.2	8.4	7.7	6.5	5.6
F	21.2	17.9	15.4	13.3	11.7	10.4	10.0	8.4	7.6	7.0	6.4	5.9	5.0	4.4
G	20.8	17.1	14.5	12.6	11.1	9.9	9.0	8.1	7.4	6.8	6.2	5.7	4.9	4.2

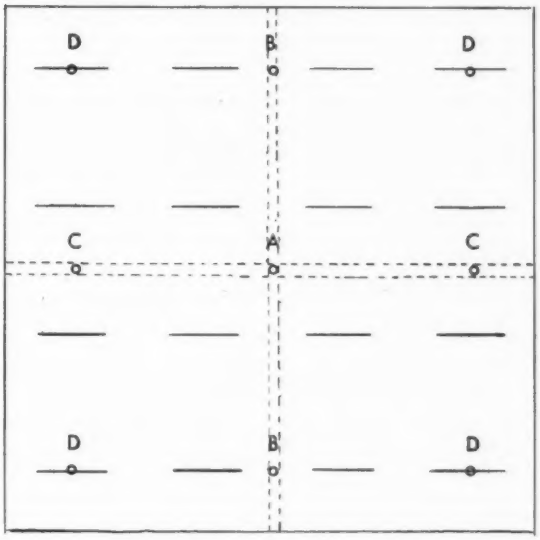
applicators. Dosage can be determined from the Quimby tables for linear radium sources.

We have devised another group of applicators, called "multiple-tube plaque applicators" (Fig. 7), to facilitate placing radium directly against superficial lesions. They may be employed either intracavitarily or externally and are particularly useful for carcinoma of the rectal and vaginal walls and the nasopharynx. Although simple in design, they can be loaded and applied with minimal radiation hazard to the operator. They are made from flat or curved blocks of bakelite with holes bored through longitudinally to hold the radium tubes. The diameter of the holes is smaller at one end of the applicator than the diameter of the radium tubes; thus, when the tubes are pulled into the applicator by their strings, they are retained in position when the strings are tied together against the end of the applicator. The bakelite wall surrounding each tube is 1 mm. thick, and there is 1.5 mm. separation between adjacent tubes. If desired, a similar type of applicator could be designed to hold an even greater number of tubes. The loaded applicator is easily handled by grasping it with 10 inch or 12 inch dressing forceps. It is retained against an intracavitary lesion by packing the cavity tightly with gauze, except in the nasopharynx, where it is held in place by threads which are drawn through the nasal passage and fastened to the cheek. If the applicator is employed to treat skin lesions, it can be held in place by means of adhesive tape. Any lesion which is larger than the active area of the applicator can be irradiated by treat-

TABLE V

DOSAGE TABLE

The 2.5 cm., Four Tube Square Applicator
(Treatment administered to four adjacent areas)



ROENTGENS PER 100 MILLIGRAM HOURS DELIVERED AT VARIOUS DISTANCES

Dosage Points	Distance in Centimeters													
	2.5 (skin surface)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0
A	28.0	24.4	21.4	18.9	16.7	14.8	13.3	12.4	10.8	9.8	9.0	8.1	6.9	5.8
B	23.3	19.9	17.4	15.3	13.5	12.1	10.9	9.9	9.0	8.2	7.5	6.9	5.8	5.1
C	21.4	18.7	16.4	14.4	13.0	11.7	10.6	9.6	8.8	8.0	7.4	6.8	5.9	5.0
D	18.3	15.4	13.4	11.9	10.6	9.6	8.8	8.6	7.4	6.8	6.3	5.9	5.1	4.4

ing multiple areas in checkerboard fashion until the entire lesion has been covered. Special dosage charts calculated from linear source tables have been prepared, which permit rapid determination of dosage when the multiple-tube plaque applicators are employed.

The problem of radium protection is important, and its magnitude is usually proportional to the number and types of radium treatments which are administered. When all means of reducing excessive exposure through vigilance have been exhausted, one should consider modification of procedures. Although the specific procedures which we have described may be applicable only to our type of practice, their basic principles may have a wider range of usefulness.

SUMMARY

We have described procedures for external and intracavitary radium therapy which have proved worth while as an aid in reducing radiation exposure to personnel who handle radium.*

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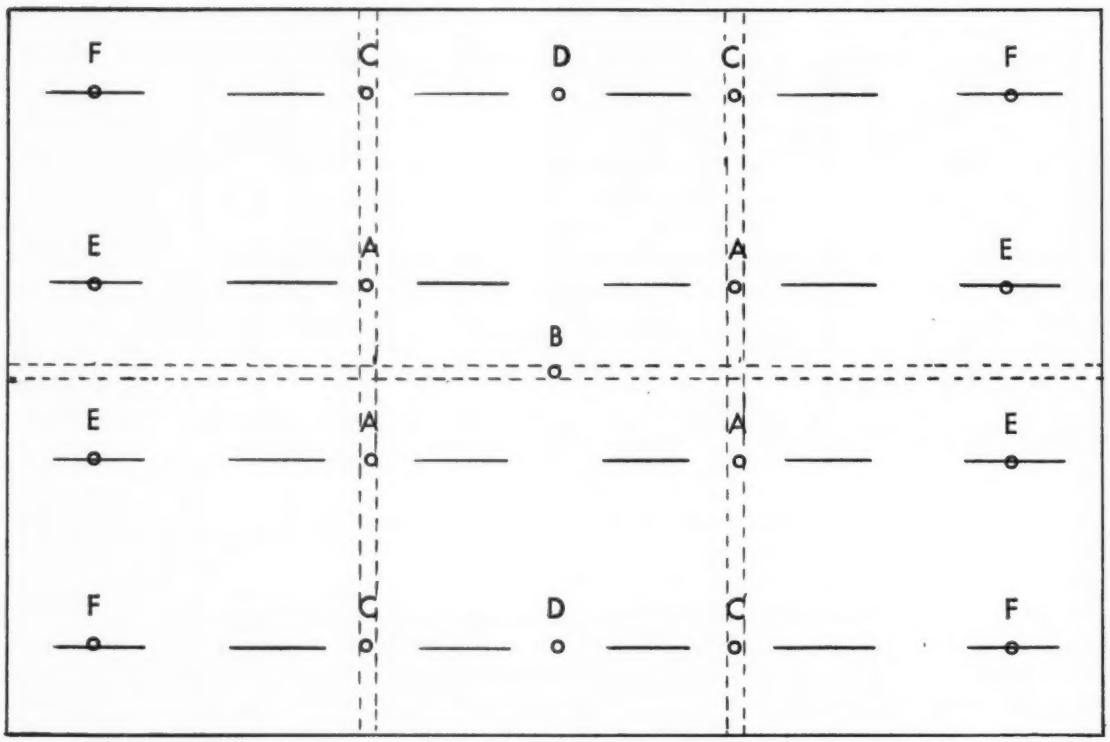
* For discussion see page 755.

TABLE VI

DOSAGE TABLE

The 2.5 cm., Four Tube Square Applicator
(Treatment administered to six adjacent areas)



ROENTGENS PER 100 MILLIGRAM HOURS DELIVERED AT VARIOUS DISTANCES

Dosage Points	Distance in Centimeters													
	2.5 (Skin surface)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0
A	20.8	18.1	16.0	14.2	12.6	11.4	10.3	9.4	8.6	7.9	7.3	6.7	5.7	4.9
B	20.1	18.1	16.3	14.7	13.2	12.0	10.9	10.0	9.1	8.3	7.7	7.1	6.2	5.3
C	17.3	15.0	13.3	11.8	10.6	9.6	8.7	8.0	7.4	6.8	6.3	5.8	4.6	4.4
D	16.5	14.8	13.3	12.0	10.9	9.9	9.1	8.3	7.7	7.1	6.6	6.1	5.3	4.6
E	15.5	13.3	11.6	10.4	9.4	8.5	7.8	7.1	6.6	6.1	5.6	5.2	4.5	4.0
F	13.1	11.1	9.8	8.7	7.9	7.2	6.7	6.1	5.7	5.3	4.9	4.6	4.1	3.6

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THE CALCULATION OF DOSAGE IN INTERSTITIAL RADIUM THERAPY*

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INTRODUCTION

THE use of interstitial radium therapy in the United States has gone through various stages. When radium needles were first made generally available, most of them had relatively high activity, sometimes as much as 5 milligrams per centimeter of active length. Treatments had to be of short duration, and radiation distribution within an implanted region was very inhomogeneous. If an adequate minimum dose was delivered within the mass, there were frequently local regions of necrosis close to the needles; these sometimes led to serious sequelae. It began to be recognized that such needles were too strong, and an activity of 1 milligram per centimeter of active length became rather widely adopted in this country. Radon seeds were available for weaker sources, and were extensively used in some institutions. However with the development of both better roentgen equipment and better surgical techniques, radium in many places fell into disuse except in departments of gynecology, where it continued to be indispensable. This, unfortunately, is still the situation in many institutions, but in many others radium is again recognized as an important therapeutic agent.

Surgeons and radiologists are beginning to find that by pooling their resources and skills, they can use interstitial radium to good advantage in many cases. It is, however, necessary to have an adequate radium supply and to consider dosage problems carefully.

The three steps in adequate interstitial radium therapy are:

1. Deciding the dose to be given and planning the implant. This is the function of the radiologist and the physicist in cooperation. If a surgeon is to do the actual insertion of the needles, he will be consulted as to the feasibility of the proposed plan.

2. Making the implant. This is done either by the radiologist alone, or by a surgeon with the assistance of the radiologist.

3. Checking the accuracy of the implant roentgenographically, and modifying dosage calculations if necessary. This is the function of the physicist, in consulation with the radiologist.

The present paper deals only with a part of the first of these steps, namely planning the implant, once the dose has been decided upon.

Much of the available information on radium dosage planning and calculation has been published in England. There radium never lost its popularity. Weaker needles came into vogue and dosage systems for their use were developed in great detail. In particular the Paterson and Parker system (developed in Manchester and sometimes referred to as the Manchester system) is widely recognized as the most complete and carefully worked out.[4] American radiologists, anxious to develop their radium techniques, would like to use it, but are deterred by the fact that their radium supply is inadequate, and particularly that their needles are too strong. It has been emphasized that they cannot use the Paterson and Parker system of calculation unless they have used their prescribed implants; there is little information on what degree of variation may be permissible. Parker's paper on the physical aspects of the interstitial treatment system and Meredith's discussion of some of

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the problems[3] are helpful, but it appeared that a more complete analysis of some parts of the situation would be useful.

It has been stated that most American radium supplies at present are based on a strength of 1 milligram per centimeter of active length, with some which may be considerably stronger. An increasing number of radiologists are adding a series of 0.5 milligram per centimeter. The Manchester system is based on two strengths, one being half the other. Their actual values are 0.66 and 0.33 milligrams of radium per centimeter of active length; their usual dosage aim is about 7,000 roentgens in six to eight days. However Paterson[5] writes, "It would seem that an equally effective system at lower tumor dose levels could be built up on a three to four day basis, using radium on the one milligram per centimeter of active length as standard (with a subsidiary stock of 0.5 milligrams per centimeter)." He further points out that if the stronger units produce the same biological result, the shorter treatment time is easier for the patient. He feels that their own particular treatment times have no virtue in themselves, but "are adhered to because useful knowledge about tolerance and tumor response at these times have been accumulated."

PLAN OF INVESTIGATION

It was decided to make a systematic study of dosage distribution in planar and volume implants, for radium distributions *approximating* those of the Paterson and Parker system, but using only needles containing 1 milligram of radium per centimeter of active length. It would then be determined what advantage would result from substituting half strength needles in certain indicated positions. *The aim was not to develop a new dosage system, but to test the applicability of the Manchester system for needles of different strengths, and for the necessarily modified distributions, to find out what latitude in planning would be permissible, retaining the use of their tables.* It was hoped that possibly with a few modifications the system could be extended. The plan was to make actual calculations for doses delivered at a large number of points throughout the irradiated volume, for a series of typical implants. Dose rates were to be calculated for the chosen points, by means of the Quimby linear source dosage tables.[6] Since Parker's calculations were done by a quite different method, small variations might be expected and would be insignificant, but large ones would be serious.

Accordingly, for single-plane and two-plane implants, three distributions of radium were studied. In the first, the division of total radium between periphery and area was essentially the same as Paterson and Parker's; for areas under 25 square centimeters two-thirds, and for areas between 25 and 100 square centimeters one-half of the radium was placed around the periphery and the remainder spread over the area. Crossing needles were placed at the ends of the active lengths of the crossed needles. Separation of needles over the area varied from 1.2 to 1.7 cm. instead of the 1.0 cm. or less recommended. In the second group, the spacing of the needles over the area was reduced to conform to Paterson and Parker. Since the needles were all full strength, this resulted in the ratio of central to peripheral radium being considerably higher than their rules specify. For fields up to 25 square centimeters, instead of the peripheral radium being twice as much, it was only about 40 per cent more, and for the larger fields, where central and peripheral radium should be equal, the central was as much as 40 per cent more than the peripheral. Finally, for the third group, the spacing was the same as for the second, but all central needles were reduced to half strength. Under these conditions, for the smaller fields the peripheral radium averaged three times as much as the central, and for the larger, 40 per cent more.

For each of these arrangements, four areas were studied, 3 by 3 cm.; 2.7 by 5 cm.; 5 by 5 cm., and 6 by 8 cm.; these cover

the range of sizes most frequently employed in this country. In the single plane implant group, for each area and for all three arrangements, dose rates were calculated in a plane 0.5 cm. from the plane of the needles, for points forming a 0.5 centimeter lattice over one quadrant. The average of these was taken, and variations of the maximum and minimum points from this average determined. The number of milligram hours required to deliver 1,000 roentgens was calculated from the average value. Some calculations were also made in the planes of the needles, for comparison with values in the plane 0.5 centimeter away.

For the two-plane implants, calculations were made for points in the plane 0.5 centimeter from one needle plane, for the mid-plane, and in some cases for other levels. The planes at 0.5 cm. from one plane of needles are those of reference for the Paterson and Parker charts.

In addition to complete implants with both ends crossed, studies were made with one or both ends uncrossed, and some work was done on the position of the crossing needles, to verify that published by Meredith for the Manchester system.[3]

SINGLE PLANE IMPLANTS

For all areas and all plans, the number of milligram hours to deliver an average 1,000 roentgens agreed with Parker's values to better than 10 per cent, in spite of the variations in radium distribution. However, when the magnitudes of the variations from the average are considered, the effects of the different radium arrangements become evident. Paterson and Parker state that with their distributions the variations in the plane 0.5 cm. from the plane of the needles are less than ± 10 per cent. Parker made some calculations for other spacings, for special cases, and found variations comparable to those in the present study.[3] In the schemes here studied, the extreme variations in the plane of reference are:

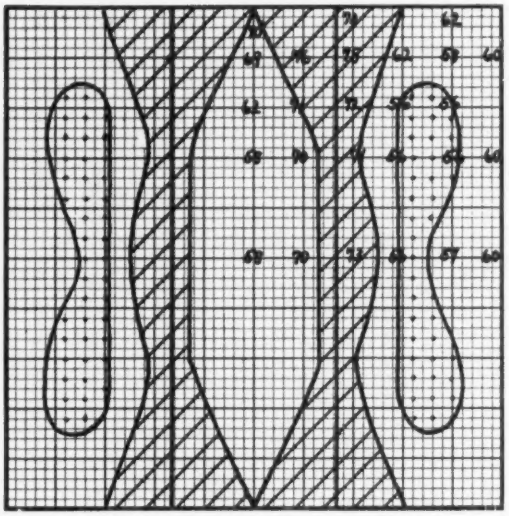
Group I, from minus 12 to plus 22 per cent.
Group II, from minus 14 to plus 18 per cent.
Group III, from minus 12 to plus 18 per cent.*

Such a statement of variation does not, however, give a fair picture of dose distribution. It may be that one or two very small regions account for the variations, or it may be that the irregularities are widespread. Charts of roentgens per hour in the plane 0.5 cm. from the needle plane are shown in Figure 1 for the three arrangements, for the 5 by 5 cm. field. In all cases the unshaded area is that which falls within ± 10 per cent of the average. The cross-hatched areas have higher dose rates, and the dotted ones lower.

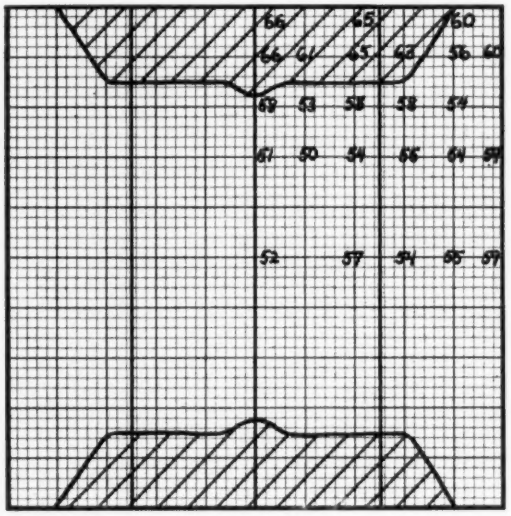
For Plan I, the regions of low dose rate, which actually are only 2 per cent lower than the permitted 10, are well within the field to be irradiated, and the area of high dose, up to 12 per cent more than the accepted variation of ± 10 per cent occupies a considerable part of the center of the field. In Plan II the low regions, down to 5 per cent lower than the acceptable 10 per cent variation, occupy 0.5 cm. strips at the sides of the implant. These should be beyond the lesion itself. The two high spots are very small and centrally located; they probably are not a serious disadvantage. Plan III has two tiny low spots centrally located; its high region occupies a little more than 0.5 cm. at the ends of the implant. These would probably be peripheral to the actual lesion. Whether doses up to 8 per cent excess in this situation are definitely undesirable is for the radiologists to decide, but it would seem unlikely.

It appears, then, that none of these plans is quite as good as the true Paterson and Parker arrangement. This would be expected, since they took great pains to work out the best. However, the variations

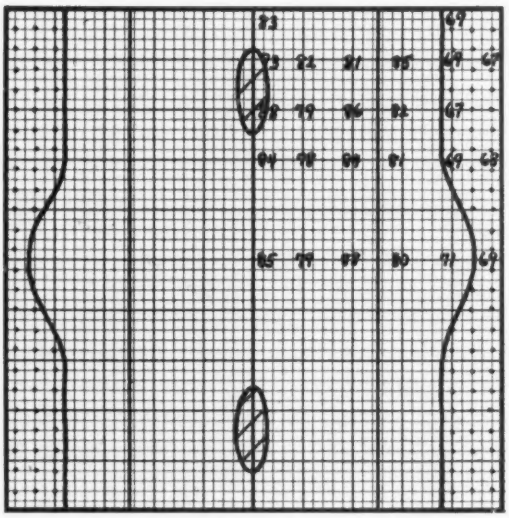
* It might have been thought that in this case, with full-strength and half-strength needles, the distribution of radiation would be in agreement with the Paterson and Parker calculations. However, they decide upon the total amount of radium and then make the proportional allotment, while here the arbitrary spacing was decided and the allotment used as a result. For instance, in a 6 by 8 cm. implant, with the inner needles spaced 1 cm. apart, the present scheme results in 28 mg. in periphery and 21 mg. inside. If Paterson and Parker were going to use a total of 49 mg. they would plan to put 25 mg. in the periphery and 24 mg. inside. This would doubtless lead to slight variations in dose rate distribution. It is also possible that differences between Parker's method of calculation and the present one give rise to some variations.



(*A*) Plan I



(*C*) Plan III



(*B*) Plan II

FIG. 1. (*A*) (*B*) (*C*) Diagrams showing radiation distribution in plane 0.5 cm. from plane of needles in 5 by 5 cm. plane implant. Numbers give roentgens per hour at indicated points. Dose rate in unshaded area ±10 per cent from average; in cross-hatched area more than 10 per cent above average; in dotted area, more than 10 per cent below average. (*A*) and (*B*) Plans I and II, all needles 1 mg. per cm. active length; (*C*) Plan III, peripheral needles 1 mg. per cm.; central needles 0.5 mg. per cm.

are probably not large enough to cause any of these plans to be unacceptable. It must be remembered that everywhere closer to the needles than this plane of reference, much greater variations appear.

RATE OF DELIVERY OF DOSE

The Manchester system was developed on a basis of administering doses of 6,000 to 8,000 roentgens in six to eight days. Using needles of 1.0 mg. per cm. and 0.5 mg. per cm., the dose rate becomes higher and the treatment time shorter. For this reason, the total dose will have to be less. According to the data of Strandqvist,[7] Garcia,[1] and Paterson,[5] who all used different radiation qualities, the reduction in dose, for a decrease in overall time from six to eight days, to three to four days, should be about 18 per cent. This implies that from 5,000 to 6,000 r in three to four days might be expected to produce the same effect as

Table I

SINGLE PLANE IMPLANTS

Average Dose Rates, and Times for Administration of Certain Doses

Area	Average Roentgens per Hour	Days to Deliver	
		5,000 r	6,000 r
	Plan I		
3·4×3·4 cm.	74	2.8	3·4
2.7×5	65	3.2	3.8
5×5	64	3·3	3·9
6×8	78	2.7	3·3
	Plan II		
3·4×3·4	74	2.8	3·4
2.7×5	85	2.5	3.0
5×5	79	2.7	3·2
6×8	98	2.1	2.5
	Plan III		
3·4×3·4	56	3·7	4·5
2.7×5	64	3·3	3·9
5×5	56	3·7	4·5
6×8	66	3.2	3.8

6,000 to 8,000 r in six to eight days. *This, of course, remains to be verified. This paper contains no clinical data.*

The average dose rates for the areas studied, and the times for 5,000 and 6,000 roentgens, are presented in Table I. It appears that the arrangements of Plan I give the doses in about the right time; those of Plan II have rather high dose rates, while those for Plan III are very slightly low. Plan II would probably be preferred to Plan I on a basis of homogeneity of radiation dosage, but the dose rate is somewhat too high for the dose level suggested above. Plan III furnishes both good homogeneity and a satisfactory dose rate; it is, however, necessary to have a supply of half-strength needles to use it.

The doses under discussion are actually the *average* values in a plane 0.5 cm. from the plane of the needles. They are neither the minimum doses to the lesion, nor the average throughout it, both of which ideas are sometimes held. They are what might be called "average minimum doses," the dose anywhere closer to the needles being greater. Parker states that the minimum dose in the actual plane of the needles is about 30 per cent higher than this, for a normal size of implant. This was verified in a few instances.

TWO-PLANE IMPLANTS

For two-plane implants the same areas and radium distributions were studied, with plane separations of 1.5 and 2.0 cm. The Paterson and Parker factors for conversion from a single plane to a two-plane implant were checked within less than 5 per cent. The mid-plane doses for the 2 cm. separation were found to be lower than the tabulated values by 10 to 15 per cent.

This last point may need comment. It is definitely stated in various papers regarding the Manchester system that doses obtained by multiplying the single plane value by the conversion factor are not the minimum dose, nor the "average minimum dose" within the volume, but are the average minimum values in a plane 0.5 cm. from one of the needle planes. As the plane separation increases, the dose for regions more than 0.5 cm. from either plane decreases, so that for a 2 cm. separation the dose at mid-plane is from 10 to 20 per cent lower than the calculated dose, and for a 2.5 cm. separation, from 20 to 30 per cent low. Figure 2 shows the general distribution of radiation in the region between the two planes in a 5 by 5 cm. implant of the Plan I type. The existence of this low dose at the center of the implanted region should not be overlooked.

Dose rates and exposure times for 5,000 and 6,000 roentgens are given in Table II,

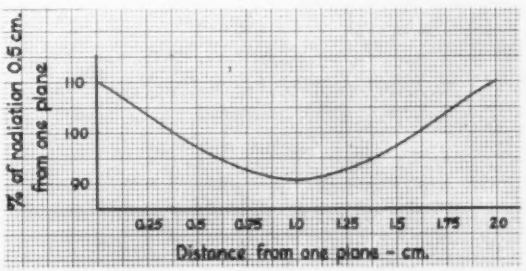


Fig. 2. Curve showing distribution of radiation in region between two planes in a 5 by 5 cm. implant of Plan I type.

TABLE II

TWO PLANE IMPLANTS

Average Dose Rates and Times for Administration of Certain Doses

Area	Average Roentgens per Hour	Days to Deliver 5,000 r	Days to Deliver 6,000 r
1.5 cm. Separation			
Plan I			
3.4×3.4 cm.	116	1.9	2.3
2.7×5	105	2.0	2.6
5×5	107	2.0	2.6
6×8	130	1.6	2.1
Plan III			
3.4×3.4	91	2.3	3.0
2.7×5	99	2.1	2.7
5×5	92	2.3	3.0
6×8	103	2.0	2.6
2.0 cm. Separation			
Plan I			
3.4×3.4	102	2.0	2.7
2.7×5	91	2.3	3.0
5×5	93	2.2	2.9
6×8	118	1.8	2.3
Plan III			
3.4×3.4	80	2.6	3.4
2.7×5	88	2.4	3.1
5×5	82	2.5	3.3
6×8	86	2.4	3.2

for Plans I and III. Data for Plan II were omitted because the dose rates are much too high for the delivery of these doses in three to four days. It is evident that with any of these schemes, the doses will usually be given more rapidly than was contemplated above, although Plan III and a 2 cm. separation is possibly acceptable.

Apparently a two-plane implant with needles all of 1 mg. per cm. of active length, with radium distribution leading to desirable homogeneity, results in a very high dose rate. This may not be undesirable clinically, but at present no evidence is available on this point. If the needles covering the area are still more widely spaced than in Plan I, namely 2 cm., or more, the average dose rate is reduced to a better level, but the lack of homogeneity may become serious. If enough half-strength needles are available to make the whole implant of them, with distribution I, for the 1.5 cm. separation, the dose rate is just half that tabulated for full-strength needles, which is a good level. In various examples in Paterson's publications, this complete use of half-strength needles is found.

UNCROSSED ENDS

Up to this point all implants have been considered to have both ends properly crossed. The problem of the uncrossed end has given rise to many questions. The Paterson and Parker rule "should it prove impossible to cross the ends of such an implant, 10 percent must be deducted from the area of the plane for table-reading purposes for each uncrossed end" has been interpreted in various ways. A study of illustrations of cases treated at Manchester indicates that the needles should be extended well beyond the lesion at the end which is not crossed. The distal part of the needle then serves the same purpose as a crossing needle at the termination of the reduced volume. However it must not be assumed that the same homogeneity is obtained within this reduced area with the uncrossed end as in a similar area with both ends crossed.

Figure 3 shows actual distributions of radiation along the central line of the plane 0.5 cm. from the needle plane, from the

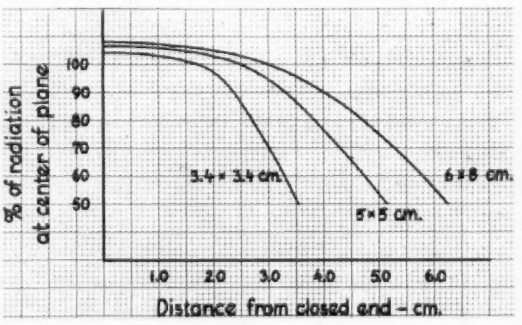


FIG. 3. Curves showing distribution of radiation along central line of plane 0.5 cm. from needle plane, when one end of the single plane implant is not crossed.

closed end to the open one, for three of the areas studied. Actual plotting of isodose lines in this plane shows that homogeneity to ±10 per cent is attained only within an area 20 per cent shorter than the overall area. Accordingly the Paterson and Parker procedure for dosage calculations in the case of the uncrossed end may be stated:

1. Deduct 10 per cent from the overall area.
2. Look up mg. hr. per 1,000 r for reduced area.
3. Leave implant in place according to reduced period—*but realize that only the four-fifths of the region which is away from the open end will receive the prescribed dose.*

If the implant is to be planned, and it is known that one end cannot be crossed, the procedure to insure homogeneous irradiation throughout the diseased region should be:

1. Calculate the area to be correctly irradiated.
2. Add 20 per cent to this *for implantation purposes.* (This is actually to be an increase in length beyond the uncrossed end.)
3. Add 10 per cent to the original area *for table-reading purposes.* (This is the same as deducting 10 per cent from the overall area.)
4. Implant the region 20 per cent longer than the tumor area, with the tumor located in the portion toward the closed end.
5. Leave the radium in place according to the period for the area 10 per cent greater than the tumor area (10 per cent less than the implanted area).

If neither end can be crossed it must be realized that the distribution of radiation is very uneven. Only the central two-thirds of the region is irradiated with any reasonable uniformity.

Two-plane implants with an end uncrossed follow the same rules as single planes. Figure 4 shows the dose distribution in a particular case.

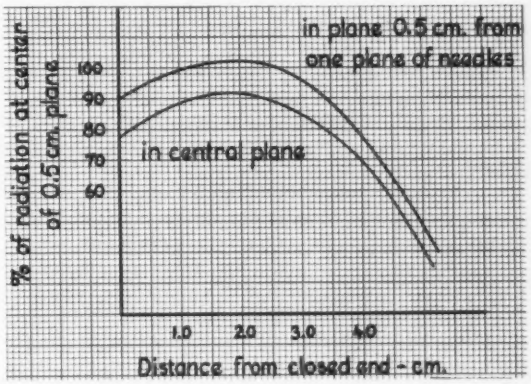


FIG. 4. Curves showing distribution of radiation along central lines of planes inside two-plane implant having one end uncrossed.

VOLUME IMPLANTS

The volume implants studied were in the form of right circular cylinders of the following dimensions: Diameter 3 cm., height 2.5 cm.; diameter 4 cm., heights 3.4 and 7 cm.; diameter 5 cm., heights 3.4, 5, 6, and 8 cm. Arrangements were considered with all needles of 1 mg. per cm. of active length, with peripheral needles of this strength and core 0.5 mg. per cm., and with all needles of the half strength. Two different core arrangements were used, one with and one without one needle in the center. Peripheral needles were in general 1.5 cm. apart, central ones in one or two rings, each about 1 cm. inside the previous one. The belt always contained at least 8 needles and the core at least 4, as recommended by Paterson and Parker.

These authors recommend as the correct partition of radium in cylindrical volumes 50 per cent in the belt, 20 per cent in the core, and 25 per cent in the ends. In the present study, when all needles were of the same strength, the partition was on the average 43 per cent in the belt, 28 per cent in the core and 29 per cent in the ends. When the inner needles were half strength, the partition was 50, 16, and 34 per cent in belt, core, and ends respectively. However, in individual cases, depending on volume, any of these values may have been 15 per cent lower or higher. For example, for volumes 5 cm. in diameter one 6 cm. high and one 3.4 cm. high, the belt:core:end partition in the first was 45:32:23, and in the second, 38:27:35.

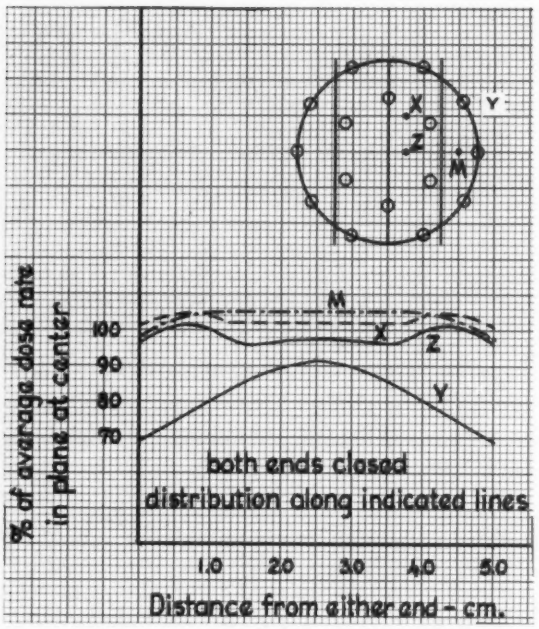


FIG. 5. Chart showing distribution of radiation inside cylindrical volume implant 5 cm. in diameter and 5 cm. high.

Dose rates were calculated for an array of points in the central and end planes perpendicular to the axis of the cylinder, and in some cases for other planes. In addition, along selected lines parallel to the axis, dose rates were calculated for several distances from the central plane. Since the Paterson and Parker values are based on the "average minimum" in the central plane, direct comparison was made on that basis. The number of milligram hours required to deliver 1,000 r for all volumes agreed with Paterson and Parker's to better than 10 per cent, in spite of the fact that radium distributions in some cases differed rather widely from their recommendations.

As to homogeneity in these implants, it is realized that within any plane perpendicular to the axis there will be regions of very high intensity immediately around each needle. However, for points 0.5 cm. or more from all needles, in the center plane the variation is of the order of ± 12 per cent, except within a millimeter or two of the periphery, where it may drop to 75 per cent of the average interior dose. For longitudinal variation within the cylinders, doses calculated along lines parallel to the axis show that, except on the periphery, the distribution is extremely good, when both ends are crossed at the level of the active ends of the longitudinal needles. Figure 5 shows the pattern for a cylinder 5 cm. in diameter and 5 cm. in height, 20 needles being used as shown, all containing 1 mg. of radium per cm. of active length. Except for points *Y* along the periphery, longitudinal variation is less than ± 7 per cent.

Meredith[3] points out that in many cases crossing needles are placed at the level of the tips of the needles, although the volume is calculated in a basis of active length. He also suggests that if crossing needles are to be beyond the active length, they should be

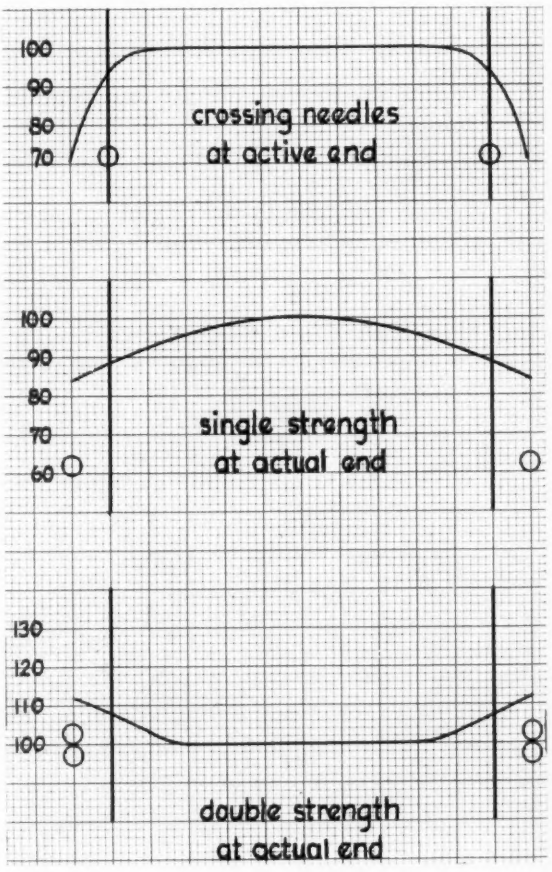


FIG. 6. Curves showing effect of position and strength of crossing needles in cylindrical volume implant 5 cm. in diameter and 5 cm. high.

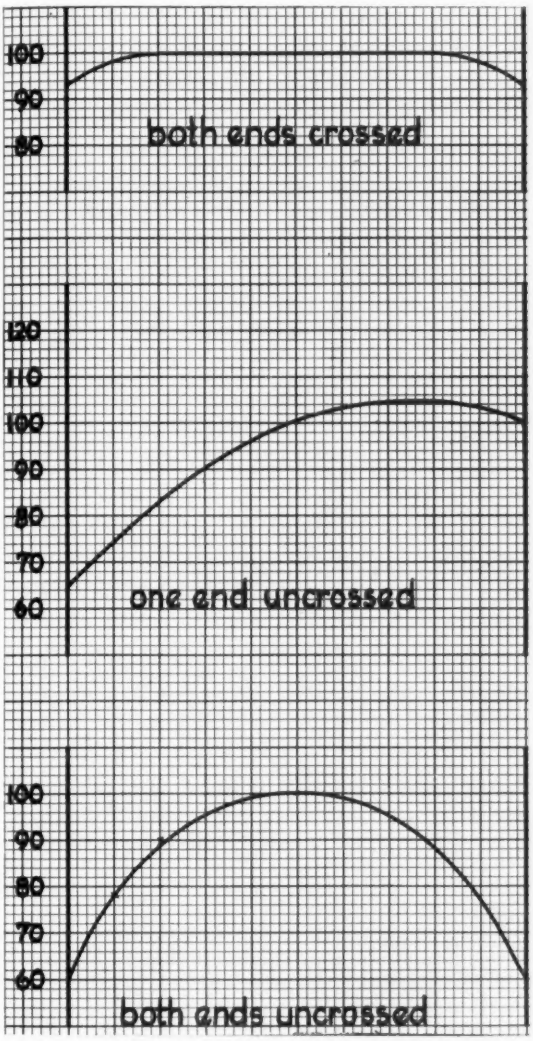


Fig. 7. Curves showing effect of uncrossed ends on distribution of radiation in cylindrical implant 5 cm. in diameter and 5 cm. high.

of double strength. The effect of position and strength of crossing needles was investigated in selected cases. Figure 6 shows results, for a cylinder 5 cm. in diameter and 5 cm. in height, for crossing at the active ends of the needles, and for single and double strength crossings at the actual ends (0.5 cm. beyond active end). Values plotted are averages of values for lines *Z*, *X*, and *M* of Figure 5. It is evident that the arrangement with crossing at the active ends of the peripheral needles gives greatest uniformity within the stated zone, although all three of them keep within ± 10 per cent of the average dose in the center plane. If, however, the intent of crossing needles farther out is to extend the zone of "fully irradiated tissue," it appears that this can be done only by using double strength needles.

Since in many instances cylindrical implants can be crossed only at one end, or not at all, it is desirable to check on radiation distribution in such situations. Meredith[3] has discussed this matter, and has pointed out that the conventional deduction of 7.5 per cent from the volume in dosage calculation does not mean that uniform dosage is obtained over all but 7.5 per cent of the cylinder length, although it "makes the calculated dose representative of dose distribution except near the uncrossed end." Figure 7 shows the actual distribution for the same cylinder as for Figure 5, when one end or both ends are not crossed. In the first case, it is seen that actually the "stated dose" does not extend nearer the open end than 30 per cent of the cylinder height. In the second, only the central half of the implant provides a uniformly irradiated region.

The dose rates with these implants are all high. For all arrangements using only needles of 1 mg. per cm. active length, the time for 6,000 r is from 36 to 44 hours. With half-strength needles in the core, these times increase to 48 to 54 hours. It is only with implants made up entirely of needles of 0.5 mg. per cm. active length that 6,000 r can be delivered in from 3 to 3.7 days. These are within the range earlier stated to be probably acceptable.

It appears, therefore, that if only needles of 1 mg. per cm. active length are available, either wider separations or shorter irradiation times will have to be resorted to. For wider separations, the homogeneity becomes definitely less. The dose level of 5,000 to 6,000 r in 3 to 4 days, as stated above, was based on the publications of Strandqvist, Paterson, and others. Of those quoted, only Strandqvist gives any data for periods less than 4 days. If the straight-line relationship of the various authors is

accepted, the two-day dose which should be equivalent to those discussed above is about 4,500 r. All arrangements using needles of 1 mg. per cm. active length have too high a dose rate even for this. The conclusion is inescapable that a supply of weak needles is highly desirable, unless a whole new series of treatment plans is to be evolved, based on very short irradiation times. This would need considerable clinical research.

COMPARISON OF PATERSON AND PARKER AND QUIMBY VOLUME DOSE DATA

One further comparison may be of interest. The Quimby values for volume dosage[2] are based on uniform distribution of radium throughout the irradiated volume, and are calculated for the point on the periphery which receives the minimum dose. Some of these are listed in Table III, for comparison with corresponding Paterson and Parker values based on the "average minimum" in the central plane. For small volumes the difference is marked; it decreases as volume increases. Actually, for the larger volumes, the radium distribution is probably not very different in the two systems; the reason for the different values being that the Quimby data are based on minimum and Paterson and Parker on average interior values. Reference to Figure 5 clarifies this. Paterson and Parker values are averages of values at the mid-points of all the lines (in this case about 99), whereas Quimby values are based on the minimum value of line *Y* (in this case 70). These two values give the ratio of the order of 1.35 found in the table.

TABLE III

COMPARISON OF PATERSON AND PARKER AND QUIMBY VOLUME DOSES

Volume cc.	Milligram Hours for 1,000 Roentgens		Ratio Q/P and P
	Paterson and Parker	Quimby	
5	100	200	2.0
10	158	320	2.0
20	251	440	1.75
40	400	620	1.55
80	633	870	1.38
100	735	1,000	1.36
125	850	1,120	1.32
150	960	1,250	1.31

SUMMARY AND CONCLUSIONS

Actual dose rates have been calculated for many points in a large series of single plane, two-plane, and volume implants, for several distributions of radium in needles of 1 mg. per cm. of active length, and of a combination of these with others of 0.5 mg. per cm. of active length. These distributions represent such approximations to the Paterson and Parker schemes as might be developed with these sources. However actual needle separations have been up to twice as great as those recommended, and ratio of central to peripheral radium has varied considerably in both directions. In spite of all these variations, average dose rates, and milligram hours to deliver 1,000 roentgens have been found to agree to within 10 per cent with the Paterson and Parker values. Homogeneity within the implants appeared to be acceptable in all cases.

On a basis of the calculations here presented, it appears that the Paterson and Parker system of dosage charts can be used with considerably more variation from their distribution rules than has been heretofore accepted. *This is not to be interpreted as stating that any arrangement of radium can be employed, and dosage calculated from their charts.* Distribution of the radium should be carefully planned, spacings should be as accurate as possible, and due attention should be paid to crossing the ends of the implants or making allowance therefor. But the needles may be all of the same linear activity, instead of some being half strength, and needle spacings may be up to 2.0 cm. without serious loss of homogeneity. The partition between peripheral and central radium may differ from the Paterson and Parker suggestions by at least 30 per cent in either direction.

Because of the larger amounts of radium in the sources, the dose rates in roentgens per hour are much higher with the implants under study than with the recommended Paterson and Parker types. For this reason, if implants of the present type are to be employed, a smaller total number of milligram hours would be expected to produce the same biological effect. It is suggested that the dose be decreased in accordance with the Strandqvist and Paterson relationships, but no clinical data on this point are presented in the present paper.

While needles containing 1 mg. per cm. of active length can be employed for the implants discussed, with due reservations as to time-dose relationship, it will be found much more satisfactory to have a supplementary stock containing 0.5 mg. per cm. This half-strength stock should be large enough to permit their use not only in the interior of implants but also as part or all of the peripheral radium in certain cases.*

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* For discussion, see page 755.

VOLUME DOSAGE DISTRIBUTION IN THE FEMALE PELVIS IN RADIUM THERAPY*†

By MORTON M. KLIGERMAN, M.D., *and* JEANNE D. RICHMOND, A.B.
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THE use of radium in the treatment of gynecologic cancer was developed by empiric application tempered by long and keen clinical observation. In recent years, however, the advantage of tissue dosage as the method of treatment prescription has been recognized. The specification of tissue dosage in radium therapy has obvious appeal to both the young therapist and to those more experienced in this excellent form of radiation. To the former it provides for control of treatment when accepted radium source distributions are used. It also serves him as a satisfactory basis for comparison of patients treated, aiding him in gaining the experience which is needed to individualize treatment in specific patients. For the more experienced therapist, for those attempting to improve on old techniques, and for those adapting the new sources of radiation to the old problem of gynecologic cancer, tissue dosage is of equal importance. Here, knowledge of tissue dosage makes it possible for experience to be scientifically and safely utilized in planning new approaches. For these reasons and because of a new program of cooperation between the Departments of Gynecology and Radiotherapy in the treatment of gynecologic cancer at the Presbyterian Hospital, a more careful study was undertaken of the dosage distribution in the female pelvis resulting from the application of radium needles according to the method described by Corscaden, Gusberg and Donlan in 1948.[2]

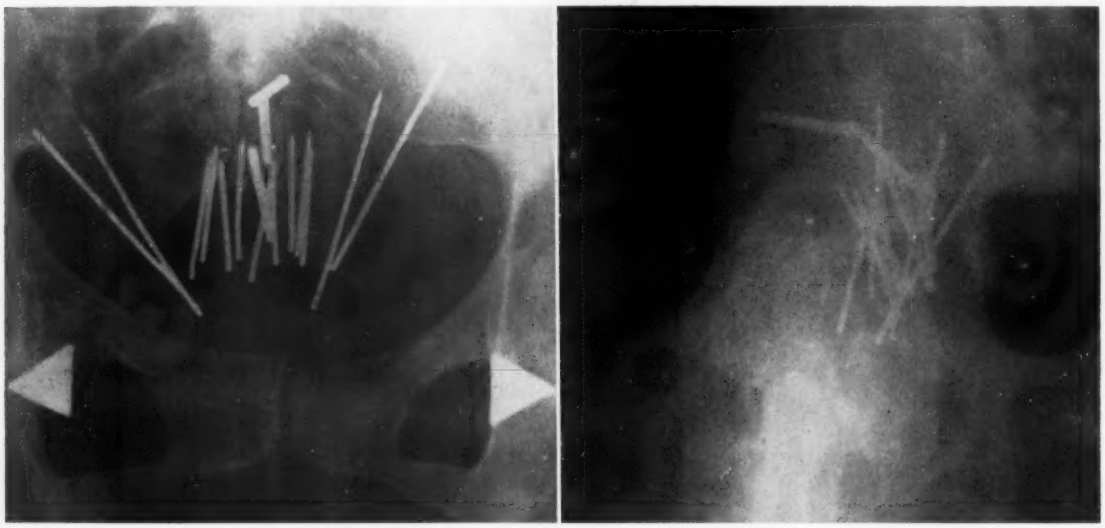

FIG. 1. This is a representative Corscaden type radium application for Stage III carcinoma of the cervix. It shows the tubes in tandem in the uterine canal, the stockade of radium needles around the periphery of the cervix, the two needles in each paracervical area and the long lateral parametrial needles.

Those treating a tumor in the pelvis are primarily interested in two things. The first is that the dosage which the tumor receives is known, no matter where the tumor

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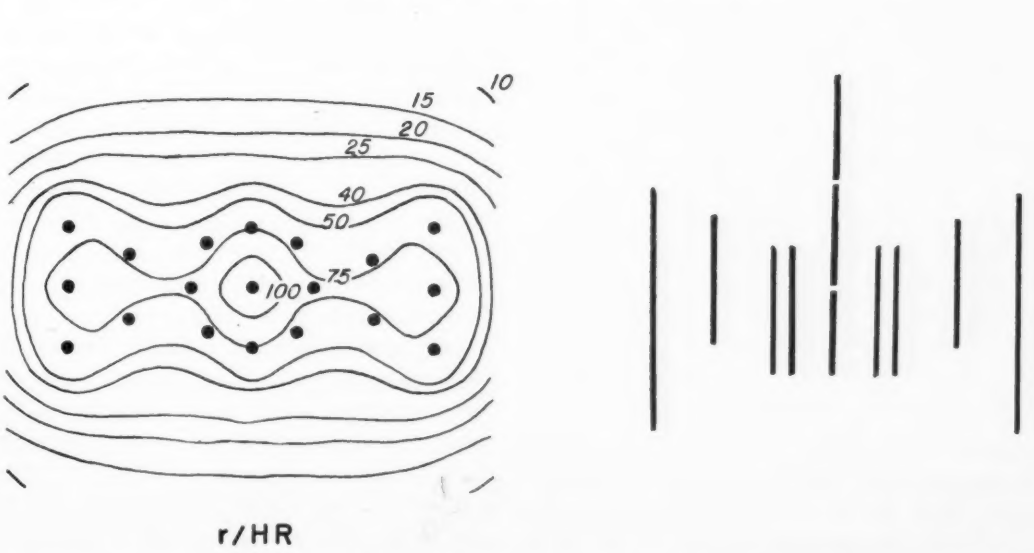

Fig. 2. The idealized application is shown in the transverse and frontal projections. The plane of the transverse section is taken through a point 2 cm. superior to the end of the lowermost intrauterine tube. The isodose lines indicate the dose in r per hour when there is 15 mg. of radium in the tandem, 1 mg. of radium in each of the needles in the stockade, 2 mg. of radium in each of the paracervical needles and 5 mg. of radium in the lateral parametrial needles.

may be. The second is that in attaining that tumor dose, the tolerance of the most sensitive adjacent normal structures (rectum and small intestine) is not exceeded. One or two fixed points are therefore inadequate guides to dosage prescription in pelvic cancer. The amount of radiation delivered throughout the entire pelvis should be known in any radium application. However, if the radium application is standardized, and if the application in a specific patient approaches the ideal, then the dose at a particular point, such as *A*, *C*, or *X*, can be utilized in rapidly estimating the dose at any point in the entire pelvis, and in the tumor-bearing area in particular. This same point, *A*, *C*, or *X*, can also be used for the purpose of recording the dose.

Examination of roentgenograms of over 40 cases of cancer of the cervix in which the radium was implanted in the Corscaden manner revealed a distribution such as is shown in Figure 1. The object of this implant is to improve the dosage to the parametrial tissues over that delivered by the Paris[3] type treatment and Waterman[4] pattern. It will be noted that the paracervical needles and the long lateral parametrial needles are distributed to irradiate the usual route of spread of cervical cancer into the parametrium. The region of the primary tumor itself, with the intrauterine tandem and stockade of needles around the periphery of the cervix, easily receives a cancerocidal dose.

Using Quimby linear source tables, the dose throughout the pelvis delivered by an idealized Corscaden type implant was calculated. All the needles in this implant had a radium content of approximately 1 mg. per cm. The three tubes in the uterine canal contained 10 mg. each. The filtration of the needles is 0.5 mm. platinum; that of the tubes is 1 mm. platinum. It was found that "hot spots" existed at the following points: 0.5 cm. lateral to the tandem, 3 cm. lateral to the tandem, and 4 cm. lateral to the tandem. The doses received at these points in the empiric treatment time of 120

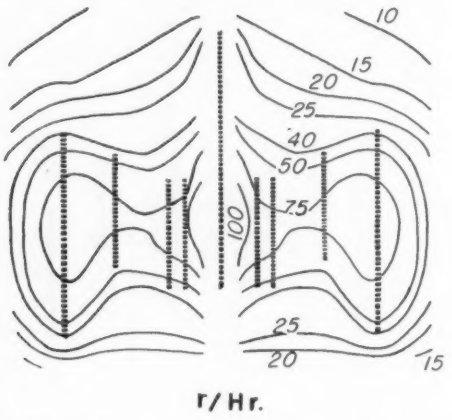

FIG. 3. The reference plane in a frontal plane taken through the superior end of the lower intrauterine radium tube (see Fig. 2). Note that the lateral parametrial area receives between 50 r and 75 r per hour in this midplane.

hours were 26,000 r, 12,000 r and 12,000 r. These hot spots were located in the midplane of the implant. In addition, there was great disparity between the dose delivered to the cervix and the dose at any point in the parametrial area including the high dosage points. It became apparent that by decreasing the amount of radium in the uterus, a more homogeneous distribution of radiation could be obtained. Accordingly, radium sources of half strength were substituted in the uterine canal and in the stockade of needles around the periphery of the cervix. The resultant improved dose distribution is shown in Figures 2, 3, 4, 5 and 6. Now, in 120 hours, the cervical tissues receive 15,000 r, a paracervical point 2 cm. out from the cervical canal receives 9,600 r, while the lateral parametrial point receives 9,100 r. This compares with 26,000 r in the cervix, 14,000 r at the paracervical point and 10,000 r at the lateral parametrial point in Corscaden's original plan, using full strength needles only, and 30 mg. of radium in the tandem.

The ability of the uterus and the vaginal mucosa to withstand an extremely large amount of radiation is well known. On the other hand, the most sensitive structures in the pelvis are the small intestine and rectum. The latter is relatively close to the radium sources. Roentgen studies with the radium in place show that the mucosa of the rectum usually is found to be approximately 3 cm. away from the cervix, the area of high intensity. The rectum, therefore, limits the amount of radiation which can be delivered in the pelvis. Previously, using needles of 1 mg. of radium per cm. in the stockade and 30 mg. of radium in the uterine canal, the rectum received approximately 5,400 r in 120 hours without permanent injury. This amount of radiation, therefore, was taken as the tolerance dose, proved by 94 applications in the last eight years. When radium of half strength is used in the uterine canal and in the cervix, it would necessitate 180 hours to deliver the same dose to the rectal mucosa. This rectal dose of 5,400 r, then would be well below tolerance in the extended time period.

With the new plan of reducing to one-half the amount of radium in the stockade and tandem, while continuing the use of full strength needles in the lateral tissues,

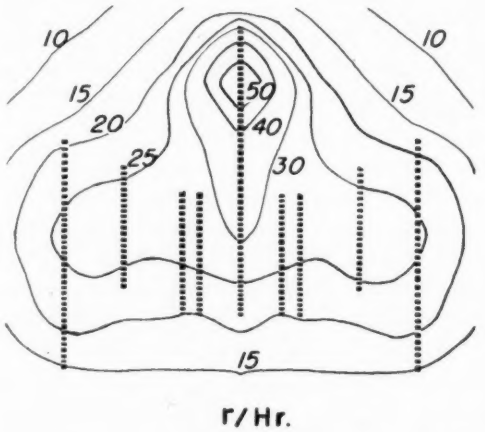

FIG. 4. Three centimeters anterior to the midplane the lateral parametrial areas receive only between 20 r and 25 r per hour as compared with 50 r to 75 r per hour in the midplane. The other doses fall off comparably except for the relatively high dosage area located superiorly and centrally. This high intensity area is due to the end of the tandem projecting anteriorly (see Fig. 1).

there is distinct improvement in the relative amounts of radiation received in the parametrial and paracervical areas when compared with that received by the cervix. The dose at the parametrial point is increased from 38.6 per cent of the cervical dose obtained under the original Corscaden plan to 61.1 per cent. At the same time, the dose at the paracervical point is increased from 55.8 per cent to 63.9 per cent. Therefore, it is obvious that the dose to the parametrial point can be increased absolutely, while the doses to the paracervical point and cervix are reduced yet maintained at an effective level. As a result, in 144 hours 18,000 r can be delivered to the cervix, 11,500 r to the paracervical point and 11,000 r to the parametrial point. The rectal mucosa receives only 4,300 r in this period, which is well within tolerance.

The tissue doses stated represent *points* in the pelvis only. Tumors, however, are volumes with many points. The ability to estimate the dose at all points in the tumor would seem important in the immediate treatment of the patient. Also, in evaluating causes for radiation failure in the treatment of cervical carcinoma, information about the dosage throughout the tumor might lead to a logical alteration in the arrangement of the radium applicators.

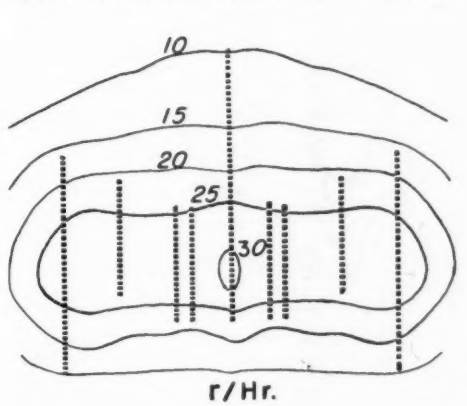

Fig. 5. The lateral parametrial areas receive between 20 r and 25 r per hour in a frontal plane 3 cm. posterior to the midplane. These are large areas of relative uniform dosage distribution.

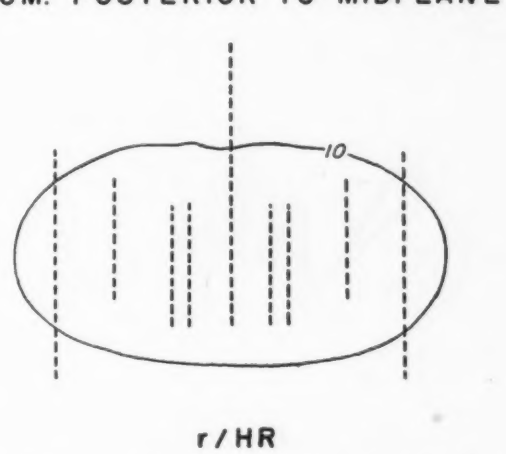

Fig. 6. Five centimeters posterior to the midplane the entire frontal plane receives approximately 10 r per hour.

Accordingly, isodose curves have been constructed for multiple frontal planes through the pelvis, anterior and posterior to a *reference plane* which is a frontal plane through the superior end of the most inferior radium capsule. This tube of radium is always in the lower cervical canal. For further orientation, the inferior end of this lowermost intrauterine capsule is placed at the external os.

The typical Corscaden implantation is reproduced in Figure 1 which shows three radium tubes containing 10 mg. each in tandem in the uterine canal, filtered by 1 mm. platinum; there is a stockade of eight needles in the periphery of the cervix, each needle containing 2 mg. of radium; there are two 2 mg. needles of radium in the paracervical tissues on each side, located approximately 2 cm. from the cervix. In the lateral parametrial area, there are usually three, but occasionally from two to five needles containing 5 mg. each. In the lateral view, it can be seen that the tandem is angled anteriorly with respect to the long parametrial needles. The active lengths of all these needles contain 1 mg. of radium per cm.; each is filtered by 0.5 mm. platinum. This implantation has been idealized in Figure 2, in which the transverse and

FIG. 7. This is a diagrammatic representation of the frontal roentgenogram shown in Figure 1. In practice, the actual film is placed on the tracing table. The isodose chart of the plane in which the doses are desired is superimposed on it (see Fig. 8).

frontal projections are illustrated. The plane of the transverse section is taken through a point 2 cm. superior to the end of the lower tube, the lower end of which is located at the external os. The isodose lines, however, represent the doses in r per hour with 15 mg. of radium in the tandem, 1 mg. of radium in each of the eight needles in the stockade, 2 mg. of radium in each of the needles in the paracervical areas, and 5 mg. of radium in each of the long parametrial needles.

The isodose lines for the midplane or reference plane previously defined are shown in Figure 3. In this frontal plane it may be seen that the parametrial area receives between 75 r and 50 r per hour. Figures 4 to 6 illustrate the isodose curves for several planes anterior and posterior to the reference plane and parallel to it. It can be seen that the dosage falls off rapidly away from the midplane. There is a relatively high dosage area located superiorly and centrally in the plane 3 cm. anterior to the reference plane (Fig. 4). This is due to the fact that the tandem is angled anteriorly (Fig. 1). Five centimeters posterior to the reference plane the dosage reaches the relatively low level of 10 r per hour (Fig. 6).

These several isodose curves can be used in a practical manner to approximate directly the dose received in an actual pelvic implant. Figure 7 is a diagrammatic representation of the radium implant shown in Figure 1. To find the doses in a plane 3 cm. posterior to the reference plane, the proper isodose chart reproduced in Figure 5 is selected. The isodose charts are drawn on transparencies, taking into account the 15 per cent magnification factor which is usually found in anteroposterior films made of the female pelvis after radium is inserted. This chart is placed over the anteroposterior roentgenogram, locating the curves properly by aligning the needles in the chart so that they correspond with the position of the needles in the actual implant as nearly as possible (Fig. 8). Doses in r per hour at any point in this plane can be read directly. By using the isodose curves for multiple planes, the doses at any point in the pelvis or tumor can be obtained.

COMMENT

There are a few skilled operators who are able to place these several needles in

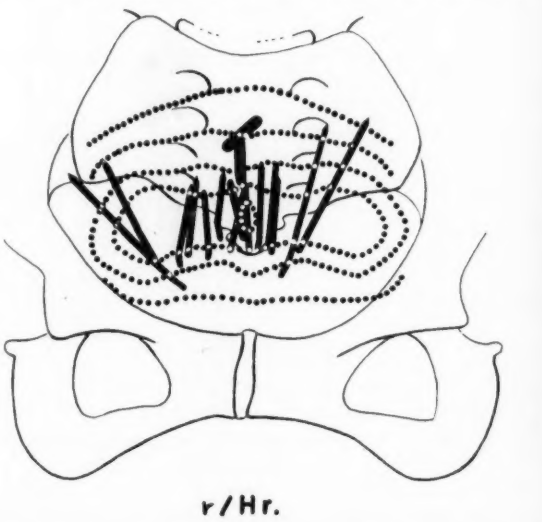

FIG. 8. The approximate doses in r per hour for a plane 3 cm. posterior to the reference plane can be read directly.

the positions which best irradiate the cervix and parametrial areas. Barnes, Morton and Callendine[1] have described the use of vaginal templates in an attempt to overcome the difficulties of needle application. From their illustrations it seems that they have been successful. Inherent in their procedure is preoperative treatment planning which is individualized for each patient. The result is not only proper spacing and direction of the needles but more uniform dosage distribution. It would seem that this technique should be given a trial in other clinics.

SUMMARY

1. The most sensitive structures in any radiation field determine the dose that can be delivered to the tumor-bearing volume. In pelvic cancer, this structure is the rectal mucosa.

2. Although homogeneity is desirable, it may be abandoned when the tissue receiving high dosage is known to be relatively radiation resistant. Such a tissue is the uterine cervix.

3. The dose throughout the tumor-bearing volume and areas of potential spread of cancer should be known, rather than the doses at one or two points only.

4. Isodose curves in multiple planes have been constructed about a standardized radium application used in the treatment of cancer of the cervix uteri.

5. By applying these curves on the anteroposterior roentgenogram of the patient with the needles in place, the approximate dose at any point in the pelvis can be readily estimated.

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DISCUSSION OF PAPERS BY VAN HERIK AND FRICKE, QUIMBY AND CASTRO, AND KLIGERMAN AND RICHMOND

Dr. L. D. Marinelli, Chicago, Illinois. The contributions made by these three papers on some very practical aspects of radium therapy should be welcomed by clinicians and physicists alike. I may begin with the problem of radium protection and mention that in a radium preparation laboratory, one is many times confronted not only with direct radiation but with scattered radiation also. I would think that, unless proved otherwise by direct instrument readings, the block shown by Dr. Van Herik should have some shielding on the side in order to prevent the radiation coming from the applicators that are being prepared, from shining at too wide an angle. I may also mention that pneumatic means of picking radium tubes offer certain advantages inasmuch as they allow manipulation around shields and thus minimize exposure of the hands. It must be stated, however, that pneumatic means must include some method of avoiding mechanical shock to the radium tube itself, because there have been several instances in which radium tubes have been opened by impact, with very expensive consequences. This particular hazard, however, can be circumvented by inserting the radium tube into a close-fitting steel cylinder and by using suction instead of pressure as the motive power.

Coming to Dr. Quimby's paper, I see that I have to erase from my notes two topics which I intended to mention because as usual, she has been quite complete in her presentation; one of them, for instance, was the pet subject of collaboration between physicist and radiotherapist, but you have already heard her suggestions as to how to go about it. I have been pleased to hear that this work on dosimetry in interstitial therapy is going to be continued. As a consequence, I cannot think of any better person to extend with an article of some sort (and I am sure she can choose the right time

and the right place) a warning to well-meaning but somewhat inexperienced operators who are using radioactive solutions of isotopes as the radioactive agent in local interstitial radiation therapy. So far as I can see, radioactive isotopes injected directly into tumors will have one definite advantage, namely, that of decreasing the "hot spots." However, there are two other problems which I think, are not easy to overcome. One is the closeness of the points at which one must inject the isotope as a consequence of the short beta-ray range, and the other is the stability of isotope concentration in situ as a function of time. If the isotope finds its way into the blood stream it will not do much good locally unless the diffusion process is much slower than the radioactive decay itself.

Finally, I would say that it seems desirable, just from an experimental viewpoint, also to ascertain by means of experimental tumors whether uniformity of radiation dose is the only or the ideal requirement of the treatment of tumors by interstitial means. One may reasonably suppose that dosimetry aimed at ischemia could work just as well and could be of easier practical application.

With regard to the third paper, by Drs. Kligerman and Richmond, I should like to mention that Miss Richmond and Dr. Quimby's collaborator, Mrs. Castro, are young comers into the field and that they are heartily welcomed into the field. We do need help in this particular aspect of radiotherapy because the necessary calculations are lengthy. I am inclined to believe that if one does not have a three-dimensional view of the dose pattern one cannot very well reach sound conclusions as to why certain results have followed certain applications.

Dr. Charles L. Martin, Dallas, Texas. After having extolled the virtues of low intensity radium needles for some nineteen years, often against considerable opposition, the statements made today relative to their growing popularity make me very happy indeed. However, I must admit that the rather complicated dosage calculations just presented would probably have prevented my taking up this type of interstitial therapy had I heard them described before I had acquired some practical experience. Most of the younger men who come to work with me are rather appalled because I do not make elaborate calculations before each implantation and they seem surprised by the good results which can be obtained with the aid of very little mathematics.

In many hospitals the radiologists lay out complex, carefully calculated patterns, but since they do not implant the needles themselves they do not realize that the surgeon often finds it impossible to carry out the theoretical plans. This is particularly true in the mouth, where one may find it necessary to change all preconceived ideas after the area to be treated has been anesthetized so that it can be carefully palpated. We find it quite advantageous for the dosage calculations and the implantations to be made by the same individual.

Neither do I think that it is essential to make an all out effort to obtain a uniform dosage of 6,000 or 7,000 gamma roentgens throughout the pattern. It is important to arrange the needles so that no point in the tumor receives less than 6,000 or more than 12,000 roentgens in seven days. With such a wide leeway simple patterns can be devised which can be used routinely without too much preliminary calculation. It is true that a few "hot spots" may appear in large implantations, but they can usually be handled successfully by electrocoagulation or surgical removal and such complications are preferable to undertreated spots in which recurrences appear.

In our hands, a loading of approximately 0.66 mg. per centimeter of active length applied for seven days has given the best results. Such needles may be used successfully in gum and hard palate lesions and produce very little bone damage. So far as I know, similar results have not been reported with a loading of 1.0 mg. per centimeter of active length. Many physicists teach that ends of all needles planted in rows must be crossed. In many locations this procedure is impossible and clinical experience shows it to be unnecessary when the needles in the rows extend well beyond tumor tissue.

I have the highest regard for Dr. Quimby and her associates and deeply appreciate the fine work that she is doing. However, I believe that the approach to radium needle therapy might be made to look somewhat less formidable.

The paper of Kligerman and Richmond holds real interest for me because we have used low intensity radium needles in the pelvis for many years. Here again the preparation of a perfect preliminary pattern is not so important as the careful implantation of the needles into the areas which reveal tumor tissue to the palpating fingers. Roentgenograms made after-

wards often show distributions at variance with the theoretical plan. Although we originally used a central capsule containing from 20 to 25 mg., as recommended by Pitts and Waterman, along with the needles, we now believe that the dosage given in this way should be reduced and in some cases it can be eliminated entirely to advantage. Certainly the capsule should not be placed high in the fundus where it may be very near the overlying loops of small bowel. Radium needles offer the best means of delivering large doses well out in the broad ligaments and it may be possible to augment such therapy with moderate doses of roentgen rays so as to control lymph node invasion just as in the neck.

Dr. Joseph L. Morton, Columbus, Ohio. It is suggested that an alternate solution, where proper radium needle strength is not available for a Paterson and Parker type of implant, would be to place the needles at the correct distances in a uniform pattern and remove the central needles early when the desired dose is reached. This creates an inequality of dose-time relationship rather than inequality in space relationship, and gives uniformity of dosage in the implanted area.

Dr. Sidney M. Silverstone, New York, New York. There are many pertinent points in all these papers but I would like to confine myself to one question with reference to Dr. Van Herik's presentation. I notice that he employed 2.5 cm. distance on his radium plaques. It has been my experience that with such a distance the amount of radiation from the point of view of milligram hours required is so great that we have a new problem there, that is, of general body irradiation. I wonder if Dr. Van Herik has made that type of calculation and could perhaps clarify that point. In my own practice I seldom employ a distance of more than 1.0 or 1.5 cm. at the most, because so much radiation is required at these greater radium skin distances.

With reference to Miss Richmond's paper, it is interesting to note that while most radium systems will take care of a Stage I, and the majority will take care of a Stage II carcinoma of the cervix, this is probably the only system that would take care of a Stage III from the point of view of radium alone. The proof will be in the results in the future; if the results are good then we will probably have to dispense with our combination therapy and use this system for treatment of all cases. I do hope it works out because I think that, on a theoretical basis, it is a very sound method.

Dr. Van Herik (closing). Of course, at a shorter radium distance a smaller percentage depth dose would be administered. Whether this is desirable would depend on the depth of the tumor and the dose to be administered. Frequently these applicators are employed to supplement interstitial therapy and in certain cases a 1.0 cm. radium distance may be desirable.

We have made measurements of the amount of radiation delivered to other areas of the body and have found that it is not excessive. Radiation sickness seldom occurs and when it does, it is usually when external therapy is being administered to the neck.

I think the important point to be emphasized is that these applicators can be designed and constructed to apply radium at distances of 1.0 cm., if desired, or at any other practical distance.

Dr. Quimby (closing). I am sure we are all completely in agreement with Dr. Martin that the aim of radiation treatment is to cure cancer, and that the idea is to get enough radiation in so that this result is achieved. There are in this room a handful of people who are quite capable of putting in an implant on the basis of experience, who do not need the pre-planning, who can guess pretty well what dose is going to be achieved through their implants after they have put them in. There are in this room also a handful of people who have never yet made a radium implant, but who hope to; and there are all gradations in between.

How is a man going to learn radium distribution unless he studies the problem? In the beginning, people like Dr. Martin, Dr. Lenz, Dr. Quick and others here, did not have the advantage of the hours and hours of arithmetic that such people as Miss Richmond and Mrs. Castro have put in, and they had to learn by experience. I doubt if their first implants were as good as the ones they are making today. It is possible for the men who study with Dr. Martin and Dr. Lenz and Dr. Quick and some of the others, to stand by them and see how they do it, but that is not the same as doing it themselves. I believe that the younger men who are coming into the field of radium therapy, and those who have been in it for a few years, are much happier in knowing that they have studied dosage distribution. They learn in lesions

of various sizes, just the sort of implants that have been successful, and so they will make them again. Eventually they will not have to calculate for every one.

I do not think that radiologists at the present time are afraid of dosage calculation. They come up before the American Board of Radiology and they know how to use the Paterson and Parker and other dosage tables. What they lack is adequate experience in actually implanting radium; this they will only get as years go by. In playing the piano or doing almost anything else, practice is necessary and with practice comes freedom, but in the beginning it is necessary to go along according to some sort of plan. It is quite true that the radiologist and the surgeon may get into the operating room and find that the plan made beforehand will not work, but if no plan has been made beforehand, they have no idea how to proceed. Dr. Martin can't tell me that he has not made any plan beforehand. He has treated so many cases that he has half a dozen plans at his fingertips. But Dr. Jones from Podunk, who has never made an implant, cannot go in with no plan at all and know where to start.

I am sure we are all aiming at the same thing. I believe that it is necessary in the beginning to do many more calculations than it is as you go along. You achieve a backlog of information which becomes part of your experience, and guides your planning. But don't let Dr. Martin tell you that it is not important to know the dosage. He tells you that with one breath and then he switches over and says it is important. He says you must get in enough to have the minimum. How are you going to know whether you have in enough to give the minimum unless you calculate it?

Mr. Marinelli has raised a whole series of questions that are outside the scope of our present discussion. We have a long-range program of dosage study, and radio isotopes will of course come into it. Mr. Marinelli is naturally interested in them; he and I started some time ago to develop dosage data for isotopes.

It is true that there may be other schemes to aim at than uniform distribution of radiation throughout a tumor. Uniform distribution is the obvious end for physicists to work toward. If some other sort of distribution is better, then either the pathologist or the radiologist or somebody else will have to tell us what he wants. We can plan any sort of distribution you want, but we are not prepared to say that you should prefer this or that sort of uneven distribution. We are here to cooperate with you, to find out what you want and give it to you.

Dr. Morton's suggestion of differential types of exposure is interesting. Dr. Morton's particular templates for putting needles in are extremely ingenious. There are all sorts of gadgets and devices which can be used; many more than have been as yet developed. This is one of the way in which physicists and gadgeteers can be of more assistance than they have been in the past.

I want to express my appreciation and that of all our group for the interesting and helpful comments we have received.

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SUPERVOLTAGE DIAGNOSTIC ROENTGENOGRAPHY

A PRELIMINARY REPORT*†

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I. INTRODUCTION

THE authors, in attempting to devise a more reliable means of demonstrating early pulmonary lesions than conventional roentgen methods, have been impressed with the potential usefulness of supervoltage roentgenography in clinical diagnosis. The advantages of supervoltage radiation in industrial roentgenography have been reported by other investigators,[2,17] and as early as 1945, Mermagen[8] described a 1 million volt human chest roentgenogram. Hare and Trump,[7] in reporting on supervoltage rotational therapy, described the properties of 2 million volt roentgenograms which they made to insure the accurate alignment of a roentgen-ray beam upon a tumor. However, no one as yet has attempted to exploit the use of supervoltage techniques for roentgen diagnosis; therefore, this preliminary report is submitted with the hope of stimulating interest in the development and further evaluation of this method. We will attempt to present the theoretical advantages in the use of supervoltage radiation in clinical roentgenography and to indicate an objective comparison of image visibility in supervoltage and conventional roentgenograms.

II. IMPETUS AND METHOD OF INVESTIGATION

Experience has shown that conventional roentgenographic techniques do not record some significant pulmonary lesions.[16] Centrally located lesions in the chest often are not demonstrated roentgenographically until they are large enough to occlude a bronchus, and lesions that have attained this size are frequently inoperable. Even visible lesions are sometimes difficult to interpret, as Garland[5] has shown. These facts led us to seek an improved roentgenographic technique which might provide a more certain means of demonstrating early pulmonary lesions and which might reduce the frequency of interpretive errors.

The problem was approached by experimentally defining the factors which limit the visibility of a roentgen image. These factors were then related to the elements of roentgenographic technique and, on the basis of these relationships, modifications in technique which were expected to increase the likelihood of image detection were proposed and tested.

III. FACTORS LIMITING IMAGE DETECTION

Our investigation of the factors which limit the visibility of a roentgenographic image will be reported in detail in the future. In brief, however, the findings of this study led us to conclude that the following properties limit the detection of a lesion in a chest roentgenogram:‡

1. The relative brightness contrast existing between the image of a lesion and its background.§

2. The random variation in the brightness of the roentgenogram.‖

‡ *Roentgenographic image detection.* Bronkhorst *et al.*[1] have reviewed the literature dealing with this subject. See also the contributions of Cobb and Moss;[3] Morgan;[9,10,11,12,13] Newell;[14] Newell and Garneau,[15] and Wilsey.[21,22,23]

§ *Relative brightness contrast* is defined as $B_1 - B_2 / \frac{B_1 + B_2}{2}$

where B_1 = the average brightness of the image of a lesion and
B_2 = the average brightness of the background.
If the background is large relative to the size of the lesion, and B_1 and B_2 are of approximately equal magnitudes this is approximately equal to $B_1 - B_2/B_2$. For convenience this function is usually expressed as $\Delta B/B$.

‖ Because of this *random variation in the brightness of a uniformly exposed area of film,* the relative brightness contrast existing between an image and its background appears to vary some-

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3. The width of the image border (unsharpness).*

4. The glare, distraction and other physiologic and psychologic effects produced by the presence of multiple other images in the roentgenogram.

Various other factors such as the technique of film reading and the nature of the surroundings in which the film is interpreted affect image detection, but since these are not related to roentgenographic technique, they will not be considered further.

IV. RELATIONSHIPS

The following considerations will serve to relate the above listed limitations to the elements of roentgenographic technique:

1. *Relative Brightness Contrast.* The likelihood of one's detecting a lesion in a roentgenogram increases as the magnitude of the relative brightness contrast between the image of the lesion and the image of its background increases. It can be shown that this relative brightness contrast is approximately equal to a function of the roentgen-ray absorption of the lesion divided by the roentgen-ray absorption of the background structures, if the lesion is assumed to replace aerated tissue. The primary objective of the roentgenographer, therefore, is to select a technique such that the absorption of insignificant background structures is as small as possible relative to the absorption of a significant lesion. The absorption of any structure depends upon its effective atomic number, density, and thickness, and upon the effective wavelength of the radiation to which it is exposed. Of these factors, only the effective wavelength of the radiation, which in turn depends chiefly upon the roentgen-ray tube potential, can always be controlled by the roentgenographer. Hence, the relative roentgen-ray absorption of a lesion and its background, and therefore the likelihood of the lesion's detection in a roentgenogram, is governed principally by the voltage applied to the roentgen-ray generator.

The relationship between the visibility of various lesions and the kilovoltage employed in a roentgen examination may be summarized as follows:

(a) Soft tissue lesions overlying the soft tissues of the lung field are best demonstrated at *low* kilovoltage because the relative brightness contrast between the images of structures which differ only in thickness, increases as their linear absorption coefficient increases and, hence, as the kilovoltage decreases.

(b) Soft tissue lesions overlying bone are most likely to be demonstrated with *high* kilovoltage technique because the absorption of soft tissue relative to that of bone increases as the kilovoltage increases.[6]

(c) Calcified lesions in the lung field are best demonstrated with *low* kilovoltage technique, again because of the increase in the absorption of soft tissue relative to that of bone as the kilovoltage is increased.

The ideal kilovoltage for use in making diagnostic chest roentgenograms, then, is the kilovoltage at which the optimum balance between these opposing factors exists.

Relative brightness contrast also depends upon the ratio of primary to secondary radiation reaching the film[11] and upon the contrast factor (gamma) of the film emulsion used.[12] Therefore, the relative brightness contrast between two images would be increased by the use of any device which limits the scattered radiation reaching the film or by the use of a "high gamma" film type, exposed to optimum density and given optimum development.

2. *Random Variation in Brightness.* The random variation in film brightness limits the visibility of only extremely low contrast images. Its magnitude depends in part upon the use of fluorescent screens[20] and would be reduced by making direct exposures.

3. *Unsharpness.* The unsharpness of an

what depending upon the points selected for measurement. Accordingly, multiple readings should be made and the relative brightness contrast should be expressed in terms of average brightness values.

* *Unsharpness* is most conveniently expressed in units of visual angle subtended at the eye of the observer. To express it in millimeters is without significance with respect to image visibility, unless the reading distance is defined.

image is often due principally to the shape of the lesion producing it but depends also upon the effective grain size of the film-screen combination, the effective area of the focal spot employed, and upon the motion of the anatomical parts during exposure.[13] Hence, unsharpness would be minimized by eliminating fluorescent screens, and by using a fine grain emulsion, small focal spot, and short exposure time.

4. *Effect of Other Images.* The distraction by other images in a roentgenogram appears to depend upon their brightness, size and proximity to the line of sight. Because of their extreme brightness, the most distracting images are those of bones, and lesion detection might be improved by reducing the roentgen-ray absorption, and hence the brightness, of these structures relative to that of soft tissue.

V. POSSIBLE MODIFICATIONS IN TECHNIQUE

Various modifications of conventional technique were considered, but none proved to be of general usefulness in improving lesion detection. Laminagraphic technique did appear to increase the visibility of lesions occurring in all areas of the chest, but unfortunately its use depends upon one's having already detected and localized a lesion by other methods. The technique, therefore, does not constitute a solution to the problem under consideration.

It appeared however, on the following theoretical grounds, that the use of very short wavelength radiation might significantly increase the likelihood of lesion detection:

1. It is impossible with conventional diagnostic equipment to obtain a kilovoltage adequate for the demonstration of small soft tissue lesions overlying calcified background structures. It would appear, therefore, that the conventional 60 to 80 kilovolt technique may not represent the optimum balance between the factors governing the visibility of lung field detail and those governing the visibility of lesions overlying the spine and ribs.

2. It has been shown that the mass absorption coefficient of bone is appreciably smaller relative to that of soft tissue for radiation generated in the 200 to 5,000 kv. region than it is for radiation generated in the 50 to 100 kv. region.[6] From this, it would appear that the detection of soft tissue lesions overlying skeletal structures would be far more likely if supervoltage radiation were employed.

3. Many lesions, particularly early bronchogenic carcinomas, escape detection in survey roentgenograms because of the presence of overlying skeletal parts. Hence, the use of supervoltage technique might increase the accuracy of roentgen diagnosis even though it resulted in the sacrifice of some lung field detail.

4. Furthermore, as was noted previously, lesion detection depends upon not only the relative absorption characteristics of the lesion and its background, but also upon several other variables, and it was believed that supervoltage technique offered advantages with respect to these variables which might more than compensate for any decrease in the contrast of lung field details resulting from its use. For example, the deleterious effects of secondary radiation on image visibility might be reduced significantly in supervoltage roentgenography since the secondary radiation generated at such voltages has a greater forward component than that generated at conventional voltages, and since, further, the use of higher energy radiation permits the use of lead screens which absorb some scattered radiation. The elimination of fluorescent screens might reduce the magnitude of the random variation in film brightness, and since the penetration of all structures should be fairly uniform, the use of very high gamma film emulsion might intensify contrasts without producing glare sources. On the other hand, it was clear that the necessity for prolonged exposures would increase the unsharpness due to motion, and it was concluded that the resultant effect of these conflicting factors could be determined only by making ex-

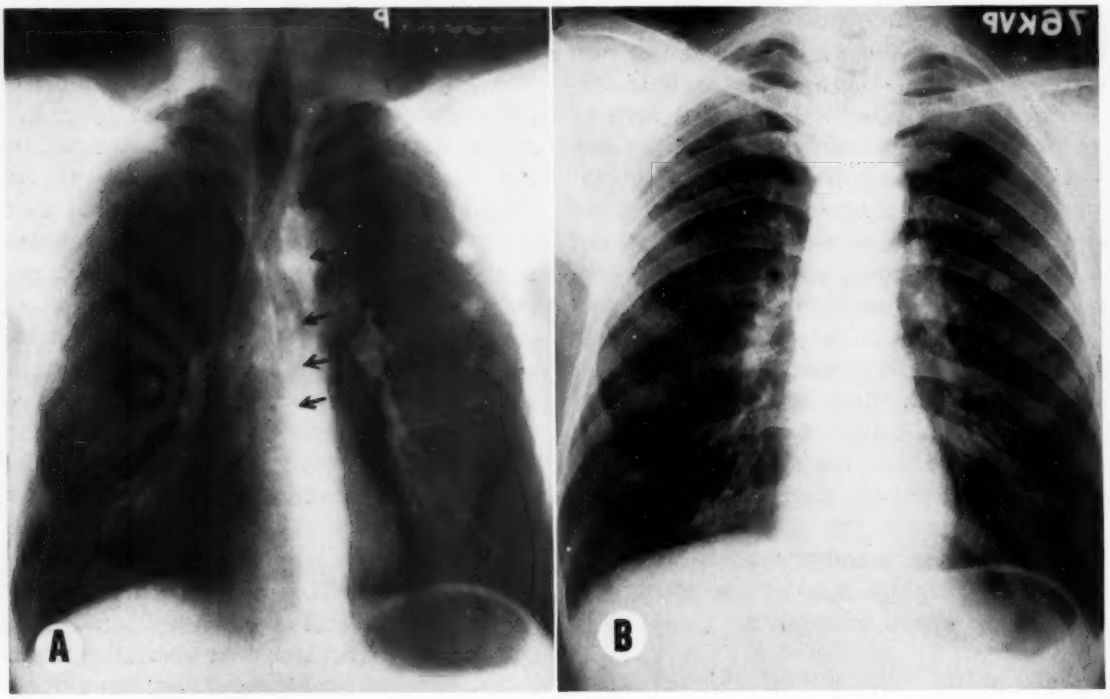

FIG. 1. Comparative roentgenograms of a human chest. The study (*A*) was made with 1,000 kv. (peak) radiation and illustrates the increased visibility of mediastinal structures obtainable in such a roentgenogram without loss of lung field detail. (*B*) is a control roentgenogram made with 76 kv. (peak) radiation. The test objects seen were attached to the subject's back and the studies were made in the posteroanterior projection.

It is impossible to reproduce in half-tone photographs the entire density scale of Kodak Industrial X-ray Film Type M, and hence the original 1,000 kv. (peak) roentgenogram cannot be reproduced accurately. The photographer has attempted to approximate the effect of the original study by special techniques.

perimental chest studies with supervoltage radiation.

VI. EVALUATION OF SUPERVOLTAGE TECHNIQUE

In view of the theoretical considerations cited above, a preliminary evaluation of supervoltage chest roentgenography was conducted with the cooperation of the General Electric Company, X-ray Department, Milwaukee, Wisconsin.

Following studies with a specially constructed phantom to determine optimal exposure factors, roentgenograms of two human chests were made with a 1 million volt industrial roentgen-ray unit. Spherical *lucite* test objects were attached to the individuals' backs over the spine and mid-lung field to test the value of the technique in recording small soft tissue lesions. The factors in these exposures were 1,000 kv. (peak), 3 ma., and 17 seconds with a 72 inch target-film distance. *Kodak Industrial X-ray Film Type M* was used with lead intensifying screens. Control roentgenograms of the same individuals were made at 76 kv. (peak), 100 ma., and 1/15 second with a 72 inch target-film distance. *Kodak Blue Brand X-ray Film* and *Patterson Par-speed Intensifying Screens* were used. A 1,000 kv. (peak) chest examination is reproduced in Figure 1 together with a control roentgenogram. The characteristics of the experimental and control studies are compared in Table 1.

VII. SIGNIFICANCE OF PRELIMINARY SUPERVOLTAGE STUDIES

Despite the unfavorable effect of the prolonged exposure, the supervoltage roent-

genograms are seen to have distinct advantages over the conventional control studies. In general, without apparent loss of any significant detail in the lung fields, it was possible to record clearly the structures of the mediastinum. This is of paramount clinical importance because, in many cases, the detection of early carcinoma is dependent upon the recognition of small endobronchial lesions in this area. A further advantage is seen in the fact that with supervoltage technique the larynx may be added to the structures which can be studied in a single chest roentgenogram.

The dose to the patient of approximately 4.4 r (measured in air) is high, but perhaps not excessive when one considers that many conventional roentgen examinations of other areas involve greater exposure than this to the patient. Moreover, subsequent work indicates that this dose can be reduced to approximately 1 r (air) by the use of faster film without significantly degrading the quality of the roentgenogram.

TABLE I

COMPARATIVE CHARACTERISTICS OF SUPERVOLTAGE AND CONVENTIONAL ROENTGENOGRAMS OF THE HUMAN CHEST*

Characteristics	*Experimental Roentgenograms* 1,000 kvp.; 3 ma.; 72 inch target-film distance (Kodak Industrial X-ray Film Type M with 0.005 inch lead alloy intensifying screens)	*Control Roentgenograms* 76 kvp.; 100 ma.; 72 inch target-film distance (Kodak Blue Brand X-ray Film with Patterson Par-speed intensifying screens)
1. Air passages visible:	Larynx, trachea, main stem bronchi and origins of lobar bronchi clearly delineated	Portion of trachea seen poorly
2. Diameter of smallest lucite test object visible over lung field:	4.2 mm.	5.6 mm.
3. Diameter of smallest lucite test object visible over spine:	7.0 mm.	None seen†
4. Clarity of lung markings:	Less obvious than on 76 kvp. study but not obliterated. Pneumothorax would be obvious	Very clear
5. Density range of films:	1.3–3.0‡	0.3–1.4
6. Duration of exposure:	17 seconds	1/15 second
7. Dose to patient (roentgens in air):	4.4 r per exposure approximately§	Less than 0.05 r per exposure[18]
8. Exposure latitude:	Great	Moderate
9. Number of films which can be simultaneously exposed to uniform density:	25‖	5[4]

* Conducted with the cooperation of the General Electric Company, X-ray Department, Milwaukee, Wisconsin.

† Objects in excess of 11 mm. in diameter were not used in this study. Subsequently, it was found that objects approximately 40 mm. in diameter were the smallest that could be seen in this area.

‡ The film emulsion used has an extremely high gamma at high densities. Hence, the supervoltage studies were exposed to unusually high density. For optimum image visibility, such roentgenograms should be viewed on a 1,000 foot-candle illuminator.

§ Phantom studies indicate that the use of faster film permits satisfactory exposures with 1 r (air) per exposure or less.

‖ This value is based on phantom studies described in the text.

VIII. POTENTIAL SPECIAL APPLICATIONS OF SUPERVOLTAGE ROENTGENOGRAPHY

Twenty-five films were superimposed and exposed simultaneously. The density of a given step of a stepwedge placed in the beam varied only from 1.6 on film number 1, to 1.3 on film number 25. This suggests that supervoltage techniques may be applicable to the production of multiple simultaneous laminagraphic studies. At conventional voltages, the maximum number of laminagrams which can be made simultaneously is five,[4] and the technique has very limited usefulness. With supervoltage permitting the exposure of at least twenty-five roentgenograms simultaneously, the method might prove to be much more useful. The problems of producing relative mechanical motion of the tube, film and patient would be great, however, with existing supervoltage generators unless it were possible to achieve the effect by causing the electron beam to scan an elongated target. This is at least theoretically possible with one type of generator.[19]

Paper straws 5 mm. in diameter filled with water were visible through the entire thickness of the phantom which corresponded to the densest portion of the mediastinum. In view of the fact that saline can be instilled into one or more lobes of an animal's lung without adverse effect, the possibility of using saline for bronchography with supervoltage radiation arises. In this manner, one might avoid the irritation, sensitivity reactions, and "lung staining" produced by the conventionally used contrast media.

Supervoltage technique should be applicable to the study of any air-bearing structure (pharynx, mastoids, sinuses) and to any study in which air can be used as a contrast medium (encephalography, myelography, pneumocystography, etc.). Hare and Trump[7] have already discussed the usefulness of certain of these techniques.

IX. SUMMARY

It was indicated on the basis of theoretical considerations that supervoltage roentgenographic technique would increase the diagnostic value of chest roentgenograms. The technique was subjected to preliminary trial and our results appear to justify further investigation and development. Therefore, additional studies to determine the optimal voltage and film type for various examinations and to ascertain if more diffuse lesions such as tuberculosis are well demonstrated by this method are now in progress.

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HEMANGIO-ENDOTHELIOMA

CASE REPORT

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THE diagnosis of hemangio-endothelioma presents a problem because the pathology is not fully understood. The literature contains few references to this rare neoplasm. The case report presented below demonstrates some of the characteristics of this lesion and confirms Willis' views on the development of the mesodermal tumors.

REPORT OF CASE

The patient, Mrs. S.N.B., a white female, aged sixty-one, was seen on March 16, 1950, with complaints of "knots" on the head, the most prominent being over the left forehead. These had been present for about two months and had recently become bothersome. There was no history of trauma. On examination, the "knots" are not pigmented, painful or pulsatile. They do not increase in size on change of position. A soft rubbery feel is imparted on palpation. She was referred for roentgen examination of the skull and chest.

The examination of the chest shows no gross pulmonary parenchymal pathologic change. The heart and mediastinum present nothing remarkable. The trachea is in the midline. There appears to be some cystic dissolution of the left shoulder girdle. A detailed study of the shoulder was ordered. This shows cyst formation and trabeculation of the left upper scapula, but the acromion is spared.

The examination of the skull shows large multiple osteolytic defects with spiculation and scalloped edges affecting principally the diploë. Only slight reactive bone changes are noted and there are no roentgen evidences of increased intracranial pressure.

Impression. These findings suggest the possibility of an uncommon neoplasm. Further clinical examination and biopsy are needed.

On March 14, 1950, a surgical biopsy was performed by Dr. William P. Philips, and tissue secured from the tumor mass on the forehead.

The following is the tissue report from the pathologist.

Gross Description. The specimen consists of many masses of dark tissue. These are small and irregular in shape.

Microscopic Description. Sections of this tissue show it to be from the skin. It shows a tumor mass made up of strands of normal actively growing cells. Some of these contain a brown pigment. The blood supply is plentiful.

Diagnosis. Malignant melanoma.

Since melanoma of the skull is very rare or even unknown,[8] the pathologist arranged to have the slides reviewed while a skeletal survey was carried out. This survey brought to light an osteolytic lesion of the left ulna in the region of the nutrient foramen with pathologic fracture and a cystic lesion of the left mandible in the posterior portion of the body. In view of the original diagnosis of melanoma, no therapy had been instituted. It was during this interval and while the patient was being followed by means of film studies of the skull, mandible, shoulder and ulna that the State Institute for the Study of Malignant Disease at Buffalo, New York, which had been kind enough to cooperate, furnished us with the definitive diagnosis of hemangio-endothelioma.

Hemangiomas of the skull are usually primary in the meninges and invade the skull by direct extension, but they may be primary in the cranium or scalp. Wyke,[10] in an excellent review, states that primary hemangioma of the skull is rare. Hemangio-endothelioma is even more rare. Brailsford[2] relates that these lesions are found in the long bones of the extremities, ribs, pelvis and vertebral column. The involved bones show cyst expansion with well marked and defined septa. Pancoast, Pendergrass and Schaeffer's[6] account of the roentgen criteria of the hemangioma differs from that of Wyke. According to them, these criteria are large vascular channels connecting areas of decreased bone density. Wyke and other observers are of the opinion that these vascular channels are more char-

acteristic of meningioma than of hemangioma, and Wyke also notes that on many occasions these tumors have been classified as melanomas and bone aneurysms. The initial pathologic diagnosis in our case was melanoma.

Cushing[4] reported the removal of a tumor of the skull that was regarded as melanotic sarcoma for three years before the specimen was again studied and a final diagnosis of hemangioma was made. Aspach[1] reported a case in which hemangioma of the skull was observed over a period of fifteen years.

Fig. 1 and 2. March 6, 1950. Posteroanterior (Fig. 1) and lateral (Fig. 2) roentgenograms of the skull showing multiple osteolytic defects and spiculation. No evidence of increased intracranial pressure. Soft tissue swelling.

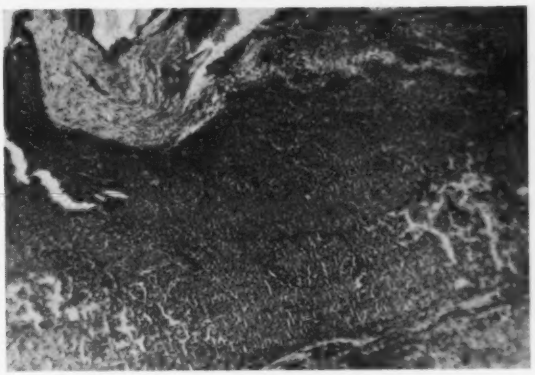

Fig. 3 and 4. Photomicrophotographs of biopsy showing anaplasia and pleomorphism.

Schwartz[7] states that the lack of enlarged vascular channels and no evidence of increased intracranial pressure point to the diagnosis of hemangioma, while Bucy and Capp[3] emphasize the "sun-burst" appearance in the roentgenograms of hemangioma.

According to Willis,[9] various mesenchymal tissues are intermutable, and vascular tissue is the most ubiquitous and plastic of all mesenchymal tissues. He regards hemangio-endothelioma and angiosarcoma not as fixed species but merely as conspicuously vasoformative elements of the genus mesenchymoma. "It is not universally understood and it is not as completely ac-

FIG. 5. March 10, 1950. Posteroanterior and lateral roentgenograms of left forearm showing osteolytic lesion with pathologic fracture.

FIG. 6. April 12, 1950. Posteroanterior roentgenogram of left forearm showing repair of lesion with cyst formation. No therapy except application of basswood splint.

cepted by physicians in general that neoplasms of mesodermal origin have so many diverse potencies."

Most of the reported cases are of the cavernous or mature capillary form of hemangioma. This is a mass of blood vessels atypical and irregular in arrangement and size. The varieties of hemangioma are distinguished according to the predominant type and arrangement of blood vessels. There is a cavernous type in which the tumor is composed of a series of vascular spaces separated by definite stroma, and a capillary or plexiform type where the vessels retain their ordinary form as coiled tubes; frequently veins predominate. The common sites are the skin, the mucous membranes of the mouth, the subcutaneous tissues and the internal organs such as liver, intestines and brain. Anaplasia, cellular pleomorphism and mitosis render the pathologic diagnosis possible. Roentgenologically, the outstanding features are cyst formation, trabeculation and soft tissue involvement. The consensus is that a definite diagnosis can only be made pathologically, however.

Since this patient has several lesions, the question arises as to whether these are all separate and independent new growths in different stages of development. Or is one the primary lesion and the others metastases? Are the roentgen appearances dissimilar because of the site of the lesions? Unfortunately, a biopsy could only be secured from the scalp as the patient was not willing to undergo any further surgical biopsies.

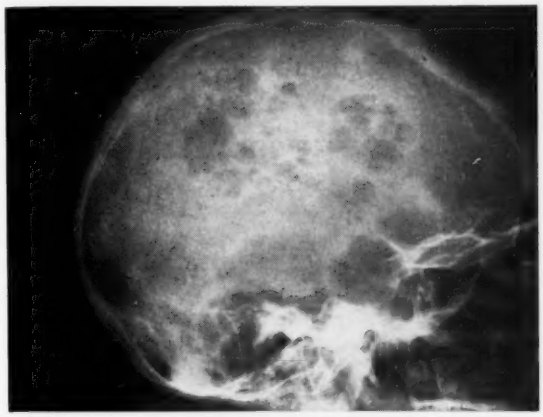

Fig. 7 and 8. No therapy administered. Note involvement of soft tissues in region from which biopsy was taken. (The detail studies of the left mandible are not given because they did not reproduce well.)

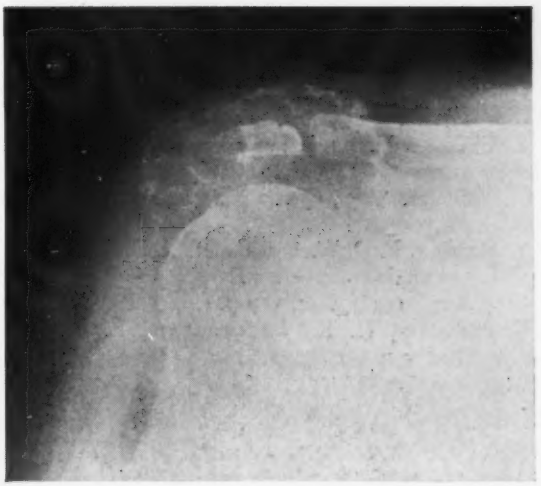

Fig. 9. July 18, 1950. Roentgenogram of left shoulder. One of the various serial studies. Note the typical "soap bubbles," cysts, trabeculations; soft tissue involvement. The acromion is spared.

Roentgenographically, the skull, mandible and shoulder fulfill the roentgen criteria of hemangio-endothelioma. The ulna, although cystic, is not trabeculated. It is of interest to note that these lesions are all on the left side of the body, which suggests a common developmental factor as hypothesized by Willis.

SUMMARY

1. A case report has been presented demonstrating the existence of four discrete lesions on one side of the body which show some of the recognized roentgen criteria of hemangio-endothelioma and suggest a common developmental factor.

2. The difficulties of pathologic as well as roentgenographic diagnosis were illustrated.

3. Illustrative roentgenograms and photomicrographs are presented.

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BRONCHOGENIC CYSTS

ANOMALIES RESULTING FROM MALDEVELOPMENT OF THE PRIMITIVE FOREGUT AND MIDGUT*

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GROSS anatomic derangement or alteration of function of an organ in the newborn is usually the result of developmental defects. Any interference with deglutition, respiratory or alimentary functions, all of which are of vital necessity, are usually recognized during the first few minutes or hours of postnatal life. Aside from those defects which are incompatible with life, the initial postnatal symptoms may be of a mild character, produced by the mere physical impingement of the anomalous structure on normal neighboring organs. Such an extrinsic pressure defect may interfere mechanically with the normal function of the trachea or esophagus, producing symptoms referable to these organs, or it may produce circulatory disturbances from displacement of the heart. On the other hand, symptoms may occur at a much later date, heralded by the development of pathologic changes within the anomaly itself, such as hemorrage, infection, ulceration or rupture of a cyst with spilling of its contents into neighboring organs or visceral spaces. Under these circumstances treatment is usually directed towards an attempt to alleviate the symptoms caused by these complications, without the fact being recognized that an underlying anomaly may be the real source of trouble. The anomalous structure may then be obscured by pneumonitis, pleural effusion, mediastinitis, atelectasis, etc. Our discussion will be limited to those anomalies occurring largely within the thorax and upper abdomen that result from abnormal development and differentiation of various portions of the primitive foregut and its derivatives. Since much has been written about stenoses of the trachea and esophagus, with or without formation of fistulas, this particular phase of the subject will be omitted and we shall deal mainly with the development of ectopic teratism (the abnormal placement of parts of organs), usually as rudimentary structures. They present themselves as "cyst-like" structures either within the mediastinum or upper abdomen. In several instances, gross anatomic defects were recognized clinically as well as roentgenographically, but the etiologic nature of this deformity was not suspected prior to either operative intervention or postmortem examination. The cysts are either of the bronchogenic or enterogenic variety, and only very occasionally is a combination of both types of epithelium encountered in a single cyst. Bronchogenic cysts, when uncomplicated by active pathology, usually produce no symptoms when they occur within the mediastinum or upper abdomen. They are, as a rule, too small to produce symptoms by direct pressure upon, or displacement of, mediastinal organs, especially when they are isolated cysts which simply remain attached to adjacent organs by loose areolar connective tissue or fibrous cords. Nevertheless, bronchogenic cysts, even when completely isolated from the tracheobronchial tree, are prone to become infected. Up to the time such complications set in, there may be no recognizable symptoms, and not a few mediastinal bronchogenic cysts produce altogether no symptoms during a normal life span. Such a cyst, Case 1 (Fig. 1 and 2), was encountered accidentally on routine chest roentgen examination in a male patient, aged twenty-

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FIG. 1. Case I. Male, aged twenty-six. Note the ovoid density in the right superior mediastinum due to a bronchogenic cyst intimately attached to the superior vena cava.

six. Because of its firm and intimate fibrous adhesions to the superior vena cava its surgical removal, after thoracic exploration, was considered impractical.

The remarkable ability of the growing organism to accommodate itself to altered

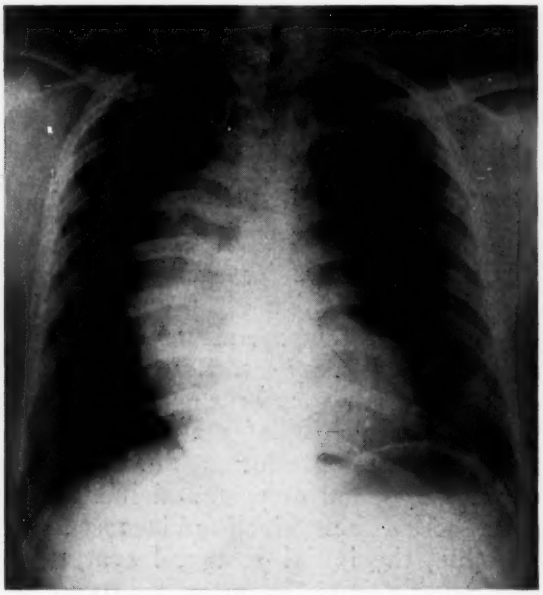

FIG. 3. Case II. Male, aged twenty-five. Large bronchogenic cyst along right mediastinal border obliterating the right border of the heart.

intrathoracic conditions allows some of these uncomplicated cysts to attain a considerable size before producing any symptoms. This is particularly true when the cyst occupies the inferior mediastinum.

Case II (Fig. 3 and 4) shows a large

FIG. 2. Case I. Lateral view showing the relation of the bronchogenic cyst to the trachea.

FIG. 4. Case II. Lateral view showing location of cyst in posterior mediastinum.

Fig. 5. Case II. Gross appearance of bronchogenic cyst following its surgical removal.

bronchogenic cyst occupying the posterior mediastinum in a male, aged twenty-six. For several months prior to its removal, the patient complained of a mild, vague discomfort within his chest and of an irritating nonproductive cough. The cough was probably due to a slight anterior displacement of the trachea; there was no displacement of the esophagus. The cyst was extrapleural and easily "shelled out" at operation. Its blood supply came, apparently, from small branches of the intercostal arteries. It measured 12 by 8 cm., contained a clear neutral fluid and was lined by ciliated columnar epithelium (Fig. 5 and 6). If the cyst encroaches on the superior mediastinum and is anchored in the relatively narrow thoracic inlet, symptoms referable to the respiratory system or esophagus develop by the time the cyst reaches a comparatively small size.

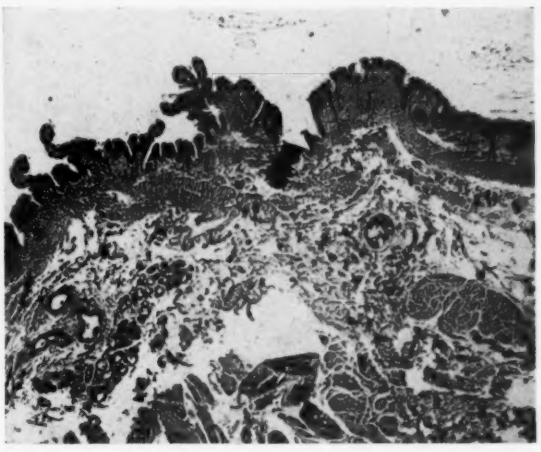

Fig. 6. Case II. Photomicrograph showing muscle bundles and lining of cyst with ciliated columnar epithelium.

Fig. 7. Case III. Newborn male. Roentgen appearance of postmortem specimen—a large paratracheal bronchogenic cyst.

Case III (Fig. 7) illustrates the postmortem roentgen appearance of a large, right paratracheal, bronchogenic cyst in an infant two days old. The cyst is attached to, but does not communicate with, the lumen of the trachea. The sharp confines of the cyst could not be demonstrated antemortem due to atelectasis of the right upper lobe. Compression of the trachea produced respiratory embarrassment which was evident at birth and progressed to the point of suffocation. The cyst (Fig. 8) was filled with

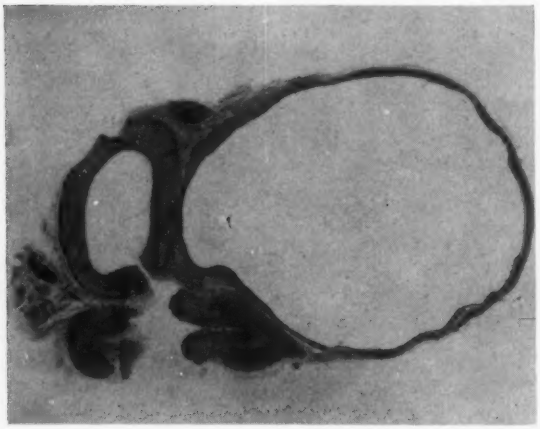

FIG. 8. Case III. Cross-section through cyst and adjacent trachea. Cyst is lined with ciliated columnar epithelium.

a clear fluid and lined with ciliated columnar epithelium.

An enlarged thymus (Case IV, Fig. 9 and 10) can produce the same symptoms and present a roentgen appearance identical with that of a paratracheal bronchogenic cyst. Again, due to the associated atelectasis, the outline of the tumor mass is hidden. Figure 11 shows the gross appearance

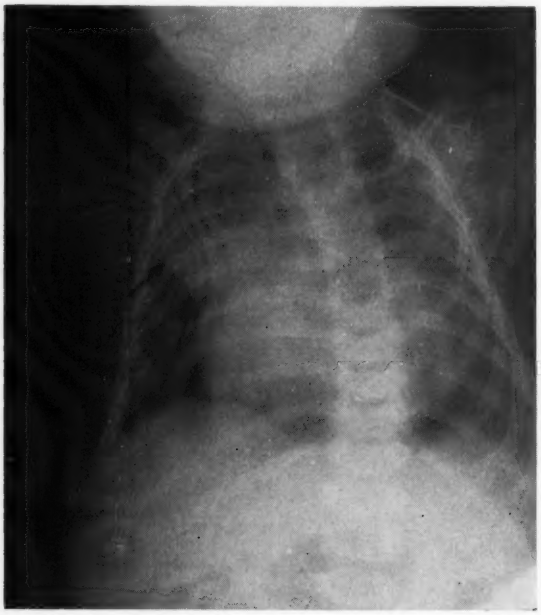

FIG. 9. Case IV. Female, aged four months. Thymoma extending into the upper right chest cavity that roentgenographically could not be differentiated from a cyst.

FIG. 10. Case IV. Lateral view showing its anterior location within the upper right chest. Note its rather sharp inferior border.

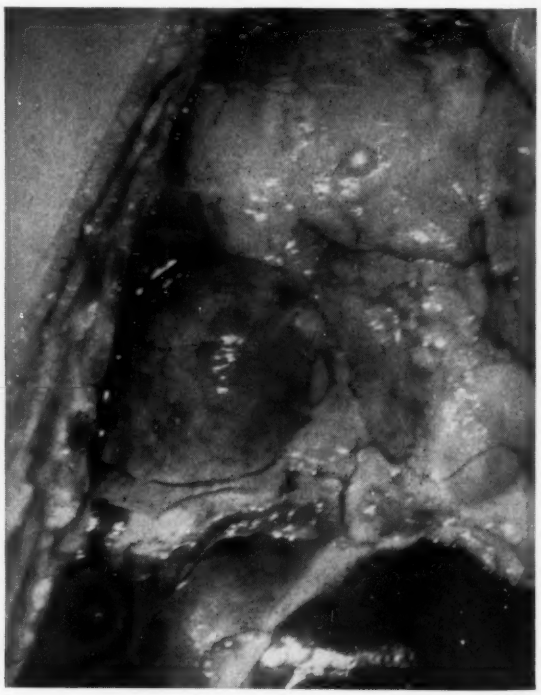

FIG. 11. Case IV. Postmortem appearance (in situ) of large thymoma in upper right chest cavity.

of a benign thymoma in a child of four months.

Occasionally one encounters a bronchogenic cyst with an air-fluid level, indicating communication with the tracheobronchial tree. Case v (Fig. 12) shows such a cyst communicating with the right stem bronchus through a small caliber rudimentary bronchus. This type of cyst is particularly liable to infection and, during the acute phase of inflammation, the associated process, whether pneumonitis, pleuritis, pleural effusion or mediastinitis, masks the underlying cause. While the acute pulmonary inflammatory phase might subside under chemotherapy or antibiotics, the infection within the cyst is prone to smolder or the cyst may become reinfected. This recurrent infection results in dense pericystic adhesions which, according to their location, may interfere subsequently with the function of respiration, deglutition, or cardiac action. Anomalies, therefore, are of practical importance because there is no convenient method of differentiating those which are likely to remain dormant from those destined to affect the organism in some manner at a later date. Prior to the era of thoracic surgery, these anomalous structures had been only of didactic interest; with the advent of thoracic surgery they have become of real clinical significance. Only complete surgical removal would bar these complications.

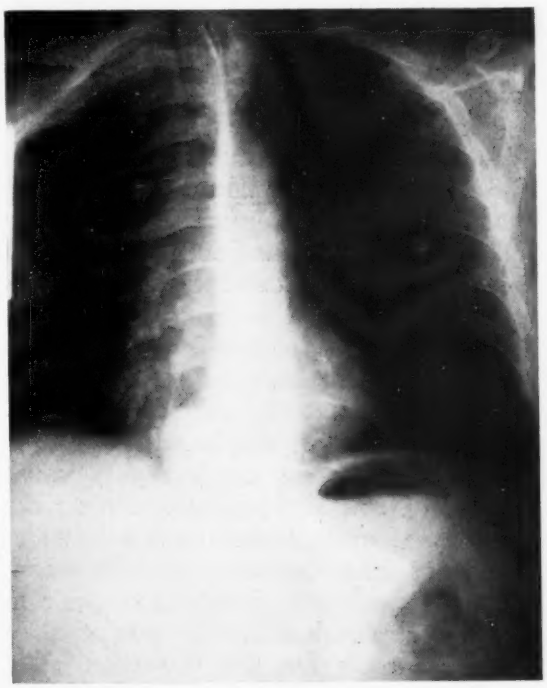

Fig. 12. Case v. Male, aged twenty-nine. Note the air-fluid level of a bronchogenic cyst seen through the heart to the right of the spine in an overexposed film.

ENTEROGENIC CYSTS

Mediastinal enterogenic cysts are rare. Blades[3] (1946), in a series of 109 mediastinal tumors in adults, found 34 benign epithelial cysts, none of which contained gastric mucosa. However, gastric cysts have been reported within the mediastinum. The occasional gastric cyst which has not ulcerated or perforated may enlarge to a point where mediastinal pressure symptoms develop. These symptoms may become evident during the first few weeks or months of life and are usually associated with those cysts having a relatively large area lined with gastric mucosa. Here gastric juice is secreted quite rapidly and its accumulation within a closed sac will give rise to a progressively enlarging cyst. Again, the location of the cyst will largely determine the type of symptoms. These are most distressing when the cyst encroaches upon the superior mediastinum where it interferes with normal respiration and eventually can lead to suffocation. The vast majority of these cysts, however, occupy the posterior inferior mediastinum. The mucosa of these cysts contains acid-secreting cells, and thus is inclined to peptic ulcer formation with a tendency to perforate. The seepage of their irritating acid fluid content into adjacent structures results in a violent, aseptic, necrotizing, inflammatory reaction. The clinical and roentgenologic manifestations of this "tissue reaction" depend upon its location and the organs involved. Thus, when a gastric cyst occupies the mediastinum, it may manifest itself clinically as a pleuritis, pleural effusion, pneumonitis, empyema, lung abscess or mediastinitis.

When gastrogenic cysts occur beneath the diaphragm they may take the form of a duplicate or accessory stomach. As such, they are usually a "closed system" which becomes distended by accumulation of its own secretions. Under such circumstances a soft tissue tumor mass may be readily seen or palpated in the mid-epigastrium or along the left costal margin. With ulceration of the mucosa and perforation of its muscular coats, a sinus tract may burrow through the abdominal wall to reach the skin, which becomes excoriated by the acid, pepsin and rennin of its gastric secretion.

Complete duplicate segments can involve the esophagus, as reported by Frank and Paul,[9] or occur at various levels along the entire gastrointestinal tract. While these duplications may show complete detachment, they usually remain attached through their serosa or muscular layer to the main intestinal tract. If only a single orifice of the duplicate portion connects with the main lumen it may superficially resemble a diverticulum. It differs, however, from the latter in that it contains all coats common to the normal viscus and is supplied with its own mesentery. An oral and aboral orifice may connect the duplicate segment with the lumen of the main gut. When both ends of the duplicate segment are blind and there is no outlet, the accumulation of secretions within its lumen causes it to assume the characteristics of an "intestinal cyst." If the duplicate segment increases in size it may impinge upon the lumen of the main gut and cause partial or complete intestinal obstruction. Marked distention of the cyst results in atrophy of its epithelial lining and occasionally of its muscular coats so that eventually only a fibrous-walled cyst remains. With interruption of its secretory function, the fluid cyst contents may become inspissated or semi-gelatinous. Later, both the walls and the cystic contents may become impregnated with calcium salts. This is readily shown on a survey film of the abdomen.

All of the anomalies reported herein have been explained on the basis of abnormal embryologic development of the primitive intestinal tract and its derivatives. While the irregularities occurring in the various steps of embryologic development have been observed and described, the pathomorphogenesis is unknown. In order to familiarize oneself with the normal embryonic development, and particularly to clarify the principles of maldevelopment, we have drawn freely from the concepts of Bremer[5] and others. For greater detail, however, the reader is referred to textbooks on normal embryology or treatises on abnormal embryologic development.[1,4]

Embryologically, bronchogenic cysts may result from faulty separation of the primitive trachea from the embryonic foregut. This separation is initiated by the formation of a bilateral longitudinal groove of the foregut in the coronal plane. As the folds, produced by this linear invagination, meet within the lumen of the gut they fuse to form two lumina. Following this, there is a gradual but complete separation of the two tubes except at the aditus laryngis: the anterior tube becomes the trachea; the posterior tube, the esophagus. According to Bremer,[5,6] there are normally small bridges of epithelial tissue spanning the partially separated primitive trachea and esophagus. These represent "sticky areas" or the last points to break away prior to complete separation. If they persist, they form the basis for the formation of a tracheo-esophageal fistula. Following complete separation, small "evaginations" temporarily remain along the adjacent margin of both the trachea and esophagus at the site of previous "bridging." If these small "spurs" or fetal diverticula do not regress completely they form the basis for the formation of either a congenital esophageal diverticulum or a tracheocele. In certain instances a "local hypoplasia" might be considered as the predisposing factor necessary for the development of these two anomalies. Due to inherent local weakness, incident to hypoplasia, the wall cannot withstand the normal stresses of intra-

luminal pressure changes and may slowly yield to form a diverticulum or tracheocele, with marked atrophy of its normal components.

While it is true that the majority of esophageal diverticula are of the acquired traction type, their congenital origin is supported by the finding of pancreatic tissue in the wall of an esophageal diverticulum as reported by Baar and d'Abreu.[2] Lewis and Thyng[11] refer to knob-like diverticula frequently found in the primitive foregut of the human embryo and lower animals such as the pig and rabbit. Bremer[5] refers to the invagination and subsequent withdrawal of embryonal epithelial cells from the submucosa of the embryonic intestinal tube. The persistence of these cells in the subepithelial connective tissue predisposes to their penetration of other coats. Their extension beyond the serosa gives rise to a potential diverticulum. Over a period of years a small diverticulum of the esophagus, through accumulation of its own secretions plus the increased intra-esophageal tension that accompanies the ingestion of solid food and liquids, may reach proportions sufficient to fill the entire retrocardiac space and extend beyond the right cardiac border, as recorded in a case report from Massachusetts General Hospital.[6] Congenital diverticula of the esophagus or intestinal tract may grossly resemble duplication cysts. The latter, however, have their own mesentery and the greater part of their wall is practically always provided with all the normal intestinal layers. This is to be expected in the duplicate segment, since it is derived through the same developmental processes as the original tube.

If there is complete separation but incomplete transportation of respiratory primordium to the anatomic site of the future trachea, a completely detached mediastinal bronchogenic cyst may result. Usually, however, it is connected by a fibrous cord to the tracheobronchial tree and occasionally by a small rudimentary bronchus. Its blood supply varies from that of indefinite origin to a supply from a branch of the bronchial artery or thoracic aorta. If the lumen of the bronchus is completely patent there may be a fluid-gas exchange so that an air-fluid level in the cyst can be demonstrated on the roentgenogram (Case v, Fig. 12).

Occasionally, there is incomplete separation of cells (from primitive foregut) predestined to become respiratory epithelium. These cells not only maintain their residence within the wall of the future esophagus but retain at least part of their "differentiation potentiality" and may develop into a simple, respiratory-epithelium lined, cyst. Cysts in the wall of the esophagus are unusual malformations. The anatomic and functional character of the cyst is independent of the system to which it is attached or embedded. The cyst may be lined with esophageal, intestinal, gastric or ciliated respiratory epithelium. Their origin from supernumerary buds of fetal diverticula of the primitive gut seems a reasonable assumption and is accepted by the majority of authors.

Case vi (Fig. 13) illustrates the roentgenographic appearance of an intramural, submucosal type of defect within the distal end of the esophagus produced by an embedded bronchogenic cyst. The bulge of the intact overlying mucosa was observed through the esophagoscope. The presence of mild symptoms of dysphagia led to its surgical removal. The cyst was lined with ciliated columnar epithelium and contained a clear neutral fluid. Figure 14 shows the collapsed cyst following its surgical removal. There is reason to believe that ciliated epithelial cysts embedded in the wall of the esophagus are of the same fundamental nature as mediastinal bronchogenic cysts or even a rudimentary accessory lung. The theory that they originate through irregular resorption of epithelial masses which physiologically occlude the lumen in the second month of fetal life cannot be applied to such cyst formations which make their appearance in the fourth or fifth week, nor to those derived from respiratory primordia after the latter have

FIG. 13. Case VI. Male, aged twenty-two. Note the intramural type of defect involving the anterior aspect of the distal end of the esophagus due to a bronchogenic cyst.

separated from the primitive foregut. The presence of columnar, respiratory, ciliated epithelium lining an esophageal cyst is understandable when one considers the fact that in the eleventh week embryo (65 mm. crown-rump) the whole esophagus is lined by columnar ciliated epithelial cells, and that even up to the sixth month of fetal life a few ciliated epithelial cells may be still found lining the lumen of the esophagus.

While the majority of bronchogenic cysts are found within the mediastinum, they are occasionally found within the upper abdomen. Their location here might be explained by the theory of dysontogenesis, wherein there is abnormal migration of cells destined to become respiratory epithelium from a more proximal to a more distal point along the primitive foregut. The relative shortness of the esophagus in the fourth week of embryonic life, followed by a rapid, intercalated, linear growth, could account for an isolated bronchial cell rest or bud anlage being carried down to the extreme caudal end of the esophagus or upper abdomen. This distal situation proves that a portion of embryonic pulmonary anlage may be widely separated from its "parent organ" and grow independently in its new location. It becomes loosely adherent to neighboring structures from which it draws its blood supply. This would tend to weaken the opinion that sequestration and growth of tissue is dependent primarily upon abnormal blood vascular development in the early embryo. It would indicate, rather, that the vascular system plays a comparatively small role in early embryogenesis. As Spemann,[17] in discussing the conspicuous width of the abnormal arteries supplying an accessory lung, remarked, "the displaced pulmonary parenchyma is apparently able to form the characteristic pulmonary blood-vessels out of any vascular system, an obvious evidence of the determining influence of the pulmonary parenchyma on the stroma."

Case VIII had a bronchogenic cyst in the region of the pancreas to which it was loosely attached by areolar connective tissue to its anterior surface. It had an independent blood supply. Why one cyst develops as a bronchogenic cyst and another as an enterogenic cyst depends theoretically upon the influence of a hormone or "organizer substance" supposedly liberates "evocators" which exert a specific directive

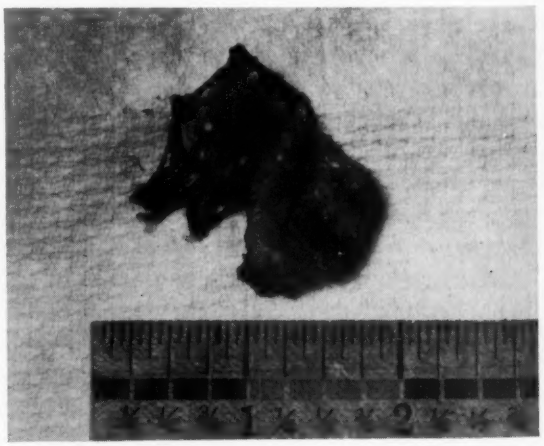

FIG. 14. Case VI.

or modifying effect upon the particular cells in question. It not only determines the ultimate morphologic differentiation and functional characteristics of the cell but influences similar cells in a different manner according to their location (Needham;[13,14] Schwartz and Williams[16]). These organizing hormones not only inaugurate differentiation of cells but may also have an inhibitory effect. The latter may account for the resorption of supernumerary buds and fetal diverticula of the primitive foregut. An alteration of their concentration may have an effect on its "morphogenetic potential," *i.e.*, a greater concentration might conceivably cause development of an accessory bud while a decrease in concentration, the result of some inhibiting agent, might result in hypoplasia or even aplasia of a specific anlage.

There is likewise a well balanced time-intensity factor, *i.e.*, its correct concentration must be liberated at the proper time with reference to the developmental stage of the embryo. A disturbance of this relationship may be a factor in the development of supernumerary structures or teratogenetic tendencies. For example, a delay in its action with reference to the growing organism might result in the formation of an accessory structure such as a "lung bud" from the primitive intestinal tube at some point distal to the location where the trachea normally develops. A variety of observations led Child[7] (1936) to the assumption of metabolic gradients in embryonic development. This conception has more recently been broadened by Dalcqu and Pasteels[8] (1938) and Brachet[4] (1947).

INTESTINAL DUPLICATION

At a very early period in embryonic development (6 weeks or 10 mm. stage) there is a rapid increase in the number of epithelial cells of the intestinal tract so that in certain regions the lumen of the tube becomes much reduced in size or even occluded. This physiologic embryonic obliteration of the lumen by masses of epithelial cells is referred to as the "solid stage." Normally the cells of this epithelial mass secrete a fluid which collects in small intercellular droplets referred to as vacuoles. These spaces or vacuoles are arranged in a linear fashion along the tube. With their expansion they normally coalesce with one another and with the main lumen. Thus with the disappearance of the vacuoles the cells eventually come to line the increasing surface of the lumen of the growing intestinal tract. When these vacuoles fail to disappear, by fusion with the main lumen, their isolation produces a double lumen. A basement membrane develops between this chain of vacuoles and the main lumen, to be followed by development of a submucosa and muscular layers converting a single muscular tube, with a core of epithelium, into two parallel lumina with more or less separate muscular coats. The fused part of the wall will contain a variable number of layers, depending on how far apart the lumina develop. The duplicate comes to lie between the layers of the mesentery. The reason for the latter position is not clear when one considers the fact that the vacuoles are not concentrated on the mesenteric side of the tube, but are seen on all sides of the main lumen. The duplicate may remain attached to the main intestinal tract simply through its serosa or by an intermingling of their muscular coats, and the lumina may remain separated or may be joined at the oral or aboral ends, or both.

Continued secretion into short closed duplicates forms spherical cysts. If the duplicate is of sufficient length the cyst becomes tubular and may attain a considerable size. Increased tension and size of the cyst may flatten the lumen of its adjacent normal bowel to the point of occlusion with clinical signs of intestinal obstruction. Under such circumstances there may be marked atrophy of the mucosal lining, submucosa and muscular layers. As mentioned previously, both the walls and the contents of such a cyst may become impregnated with calcium salts and so be readily demonstrable in the roentgenogram (Case VII, Fig. 15). Occasionally,

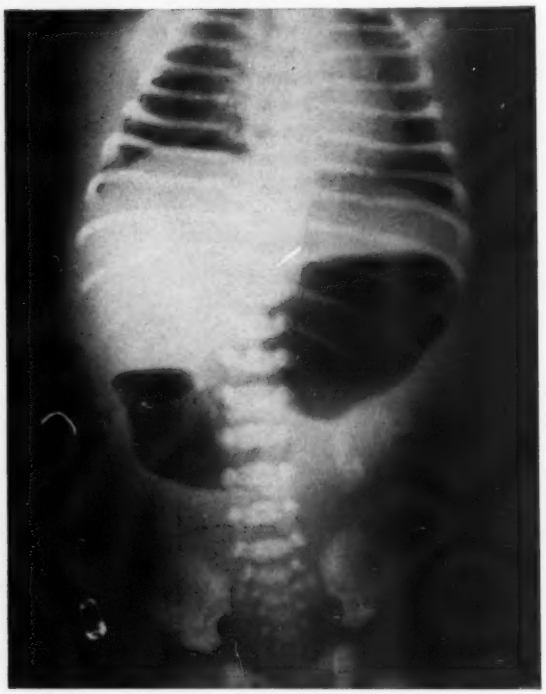

FIG. 15. Case VII. Male, aged two days. Note the area of calcification in upper left abdomen. Calcium salts have inspissated a small duplication of upper jejunum. Patient also had an atresia of jejunum just beyond the ligament of Treitz.

a duplicate with its own mesentery projects into the peritoneal cavity. Its bulbous distal end becomes buried subperitoneally, while its proximal end opens into the main lumen of the gut. This type of duplicate might be mistaken for diverticulum.

The development of a duplicate stomach apparently does not follow the same pattern as duplication in other portions of the intestinal tract. Embryologically the stomach does not pass through a solid cellular phase as do the narrower tubular portions. While there is normally a thickened epithelial layer with relatively few vacuoles, these lie chiefly along the lesser curvature, *i.e.*, opposite to the side on which the duplication develops. This situation lacks the fundamental requirements of site, cellular phase and vacuoles to account for the development of an extra stomach along the greater curvature side of the main stomach. The development of an accessory stomach must therefore be accounted for in a manner other than by way of a long chain of vacuoles within an epithelial mass.

CASE VIII. R.H., a newborn colored female infant with polyotia and what was clinically diagnosed as craniostenosis. Patient did well, was discharged only to be readmitted three weeks later with "difficult respirations" accompanied by cyanosis. Examination at this time revealed a left hydrothorax and a soft fluctuant mass in upper left abdomen. The pleural effusion was blood tinged and showed no growth on culture. After repeated tappings, the lung field remained clear, but there was a slight increase in size of the mass in the upper left abdomen. A bone survey, roentgen examination of the genitourinary and gastrointestinal tracts were within normal limits except for the extrinsic pressure defects along the greater gastric curvature. The possibility of a neuroblastoma of the left adrenal gland was entertained but the poor physical condition of the infant negated a laparotomy, and the patient died from terminal bronchopneumonia at the age of ten weeks.

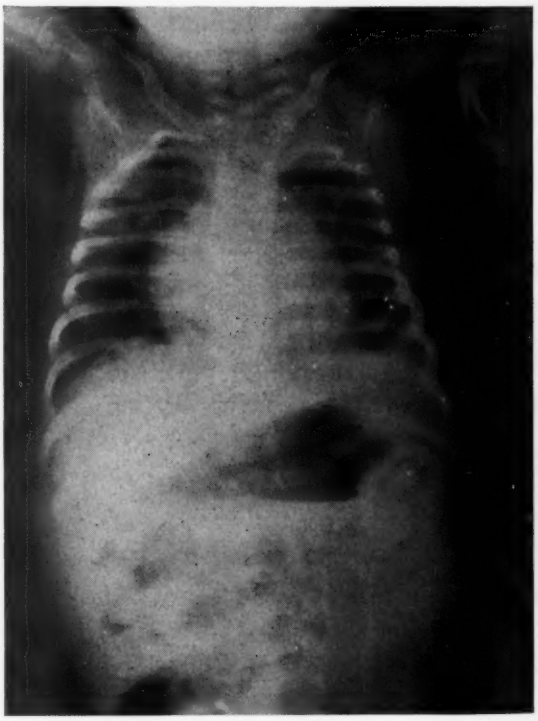

FIG. 16. Case VIII. Female, aged four weeks. Erect position showing a soft tissue density along the left inferior axillary border and double indentation along greater curvature side of gas-filled stomach.

Fig. 17. Case VIII. Barium-filled stomach showing the upper extrinsic pressure defect produced by the duplicate stomach and the lower defect (arrow) produced by an abdominal bronchogenic cyst.

Postmortem examination disclosed an abdominal bronchogenic cyst, duplicate stomach, congenital heart lesion (interventricular septal defect), a cranial metopic suture line and an extracranial bone obliterating the anterior fontanelle.

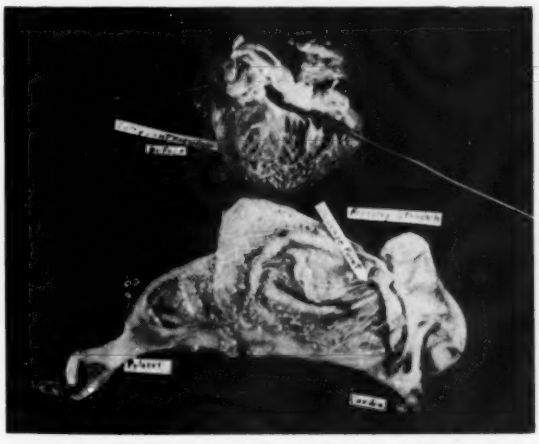

Fig. 18. Case VIII. Gross appearance of stomach showing a complete muscular partition between the main and small accessory stomach. (Upper part of photo shows a congenital interatrial defect of the heart.)

Gastric duplication or accessory stomach usually occurs along the greater curvature, as is shown in Figures 16, 17 and 18. In the case here presented, no connection between the lumina could be demonstrated by barium meal studies, and the gross specimen showed a complete partition. Microscopically (Fig. 19), this partition is represented by an intermingling of muscle bundles common to the muscular coats of both

Fig. 19. Case VIII. Low power photomicrograph showing interlacing muscle bundles within the wall common to both stomachs.

stomachs, such as that reported by Ladd and Gross.[10] Both the main and duplicate stomach were lined by typical gastric mucosa (Fig. 20). The abdominal bronchogenic cyst and photomicrograph are shown in Figures 21 and 22.

EMBRYOLOGY OF DUPLICATE STOMACH

During the second and third fetal months when there is normally a dorsoventral compression of the bulging left side of the prim-

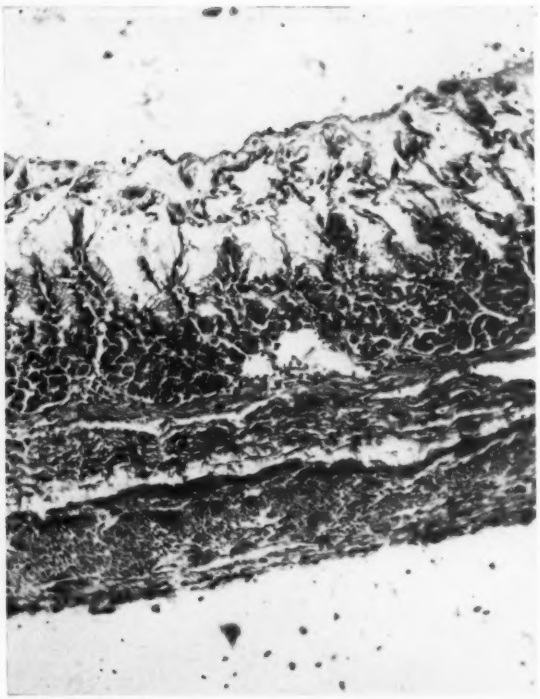

FIG. 20. Case VIII. Low power photomicrograph showing gastric mucosa lining the duplicate stomach.

FIG. 21. Case VIII. Gross specimen consisting of liver, stomach, pancreas, and the large bronchogenic cyst lying on the anterior surface of the pancreas.

itive stomach, its walls are thrown into deep folds and the cavity becomes "slit-like." According to Bremer,[5] a double stomach results from fusion of these two longitudinal folds running along the ventral and dorsal surface of the primitive gastric lining. Fusion of these epithelial cells forms a bridge for the development of a submucosa, and later, of muscle fibers, to produce a common wall between two separate portions of the stomach. The plausibility of this method of malformation is based on the fact that fusion of adjacent longitudinal

FIG. 22. Case VIII. High power photomicrograph showing ciliated columnar epithelium lining the abdominal bronchogenic cyst.

folds is a common embryologic procedure in other parts of the body.

It is interesting to note that in the reported cases, peristaltic action was elicited in isolated cysts and tubular duplicates but was not evident in the gastric duplicate (Millar and Robertson[12]). Bremer[5] explains this difference in dynamic physiology as a difference in the anatomic distribution of nerves to the two structures. Both types of duplicates lie within the mesentery. The

vagus nerve supply to the intestinal duplicate is by way of its mesentery. The nerve supply to the gastric duplicate, however, is not through its mesentery, but approaches from the lesser curvature side of the main stomach. Under these circumstances, it is probable that the fibromuscular partition between the duplicate and main stomach might act as a barrier to the passage of branches of the vagus nerve and its motor terminals to the duplicate. Because of this "mechanical obstacle" to the vagus, the musculature of the duplicate never assumes activity and is not influenced by extrinsic vagal stimuli.

While peristaltic contraction waves are dependent upon the intrinsic nerve plexus, rhythmical contractions are purely myogenic, *i.e.*, they depend solely upon the inherent rhythmical property of the intestinal muscle itself. The contraction waves of the bronchogenic cyst (Case II) were so prominent at the time of its transthoracic removal that the attending surgeons momentarily considered the possibility of its being a diaphragmatic herniated portion of bowel. It seems, therefore, that muscular contraction is not dependent upon any nerve supply but rather upon the state of development of the musculature which composes its wall, whether it be a bronchogenic, gastric or enteric cyst.

Respiratory epithelium in the form of bronchogenic cysts or fetal pulmonary parenchyma can also occur on the outside of the thoracic cage. These cysts produced no symptoms and may be found clinically as a subcutaneous, malleable, soft tissue tumor mass on the chest wall. They come to lie outside the thoracic cavity, through a process of pinching off of pulmonary tissue during the embryologic development of the sternum. The latter develops from fusion of two longitudinal parallel bars of primitive cartilaginous connective tissue. It is possible that in this process of fusion a portion of the developing pulmonary parenchyma may protrude through the gap and become "pinched off" as the bars fuse. Thus a small portion of lung tissue comes to lie anteriorly, outside the thoracic cavity.

Case IX. H.C. A white male, aged fifteen months, was admitted for investigation of a soft mass on the anterior chest wall—infraclavicular region. The mass was "cystic," slightly movable on the chest wall and measured approximately 4 cm. in diameter. Roentgen examination of chest was normal. The mass was incised and a sanguineous, viscid fluid exuded. It continued to drain for several weeks, became infected with *Staph. aureus* and was then removed in toto. Microscopically the cyst lining ranged from a squamous, through a low to a tall columnar epithelium with some cilia. Beneath this epithelial lining there was evidence of a chronic inflammatory reaction.

Diagnosis: Bronchogenic cyst.

Comment. There was no evidence of developmental anomalies or traumatic defects of the bony thorax; no evidence of rib caries or soft tissue abscess and no crepitation or variation in size during extreme changes in intrathoracic pressure. Following its complete excision there was no evidence of recurrence, all of which tends to rule out the possibility of herniation of the lung through a localized area of anatomic weakness.

The same embryologic explanation may apply to the rare occurrence of ectopia cordis cum fissura sterni. On the other hand, incomplete fusion of the longitudinal halves of the sternum has been encountered by the authors without any type of thoracic herniation.

While it is histologically possible to determine accurately the type of congenital defect or abnormality and, on the basis of experimental embryology, to follow the abnormal developmental steps, the specific reason for this developmental aberration remains obscure. It is known, however, that environmental factors can produce in the developing embryo malformations closely resembling, or indistinguishable from, those considered as genetic differences. Intensification of hormonal activity or alteration of the time period in which the growth hormone or organizer substance becomes operative might conceivably result in anomalous or supernumerary structures. Mechanical factors also can hinder

the development of an otherwise normal structure. This is particularly evident in the malformation of a lung or lobe secondary to thoracic deformities, congenital diaphragmatic hernia, cardiac hypertrophy, abnormal development and distribution of the vascular system, and so forth. As indicated earlier, in most instances accessory structures do not function as miniature units but exist as nonfunctioning purposeless organoid structures such as bronchogenic cysts, diverticula, enteric cysts, or accessory stomach.

DIAGNOSIS

While the uncomplicated intrathoracic anomalous structure is readily revealed on the roentgenogram, there are rarely any diagnostic signs for its correct interpretation. The inferior mediastinal accessory lung or bronchogenic cyst is much more common than the so-called tracheal accessory lung in the superior mediastinum. Up to 1947, 37 cases of accessory lung in the lower mediastinum were reported, but only 2 in the upper mediastinum (Valle and White[18]). In 1949, 2 additional superior mediastinal accessory lungs were reported by Baar and d'Abreu.[2] The majority of bronchogenic cysts produce no symptoms and are discovered on routine chest examinations in both infants and adults.

On the other hand, the gastrogenic cyst is usually of significance in the first year of life. Of 27 cases reported up to 1948, only 2 were found in patients over fifteen years of age. Nine were infants under one year. They usually arise in the posterior inferior mediastinum and, as they increase in size and encroach on the pleural space, the majority of these cysts present themselves to the right of the spine. Twenty-one of the 27 thoracic gastrogenic cysts reported protruded into the right hemithorax. It is assumed that the aorta acts as an effective barrier to extension into the left hemithorax.

As stated above, there are no roentgen signs that lead unerringly to a precise diagnosis of mediastinal cyst unless an air-fluid level is demonstrable. When this is present, it favors the diagnosis of bronchogenic origin, otherwise the appearance is that of any solid or fluid-containing mediastinal tumor. Their shape may show a tendency to change from a spherical outline in the recumbent position to a "tear drop" in the erect position. While this change is theoretically probable, in practice it is difficult to demonstrate. The degree of change in form and outline depends upon the firmness of the cyst wall, its degree of fixation by neighboring structures or its immobility due to adhesions. Small cysts not seen on the conventional roentgenogram may sometimes be revealed on laminagraphic studies of the mediastinum. Distortion and displacement of the barium-filled esophagus depends upon the size of the cyst. Where doubt exists as to the nature of the lesion, esophagoscopy may be helpful in excluding endoesophageal lesions, and bronchoscopy, in excluding endobronchial lesions. Aspiration may be justified if one cannot definitely differentiate a mediastinal cyst from loculated pleural effusion. If a bronchogenic cyst is encountered, the fluid may vary from a thin, clear watery to thick creamy material resembling pus; the cellular content, however, will clearly differentiate it from pus. If the fluid is acid and contains peptic enzymes, it establishes the diagnosis of gastrogenic cyst.

Symptoms such as cough, dyspnea or dysphagia depend upon the size and location of the cyst. In infants cyanosis may be transient, occurring only during feeding, crying or straining. With enlargement of the cyst, ensuing atelectasis may result in permanent cyanosis. Displacement of the heart, or pressure on cardiac nerves, may result in palpitations. Hemoptysis is usually the result of complications such as fistula between the cyst and air passages in gastrogenic cysts, peptic ulceration with perforation, and communication with the esophagus may result in either hematemesis or melena.

CONCLUSION

Since the roentgen signs for accurately establishing the diagnosis of "cyst" are meager, the type of cyst (uncomplicated) can be determined only by histopathologic study of its wall or indirectly through examination of its contents. In adults the differentiation of cysts from malignant or potentially malignant tumors is so difficult that excision is both desirable and advisable. In infants and children, gastric cysts, if at all productive of symptoms, are usually rather rapidly lethal unless removed. Finally, the diagnosis of the type of cyst is scarcely necessary since almost all cysts of the mediastinum may give rise to lethal complications and should therefore be removed surgically unless there is a serious contraindication.

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TRICUSPID INSUFFICIENCY

OBSERVATIONS BASED ON ANGIOCARDIOGRAPHY AND CARDIAC CATHETERIZATION IN TWELVE PATIENTS*†

By CHARLES T. DOTTER, M.D., DANIEL S. LUKAS, M.D., *and* ISRAEL STEINBERG, M.D.

INSUFFICIENCY of the tricuspid valve results in regurgitation of blood from the right ventricle into the right atrium during ventricular systole. This is associated with an elevation in the central venous pressure which may be manifested by distended veins, enlargement of the liver, dependent edema, and ascites. These signs are common to tricuspid insufficiency and congestive heart failure although the two conditions may exist independently or simultaneously. In tricuspid insufficiency the increase in central venous pressure is principally the result of transmitted pressure from the right ventricle and therefore reaches a maximum at the time of ventricular systole.[3] There thus occurs an abnormal central venous pulse which is clinically apparent in the form of pulsatile neck veins and expansile liver. The above signs, plus the demonstration of a systolic murmur in the tricuspid region, form the basis for the clinical diagnosis of tricuspid insufficiency.

Tricuspid insufficiency usually exists in association with rheumatic mitral stenosis. Its clinical manifestations may be exaggerated by congestive failure. Autopsy studies[1,2] have indicated that tricuspid insufficiency accompanies mitral stenosis in up to 33 per cent of cases while cardiac catheterization studies at this center[8] have indicated a similar incidence of 36 per cent.

The contributions of routine roentgenologic methods to the diagnosis of tricuspid insufficiency have been few and generally unrewarding. Right atrial, right ventricular and hepatic enlargement may be demonstrated, but are common to both congestive heart failure and tricuspid insufficiency. In the latter condition, it is sometimes possible by roentgenoscopy or roentgen kymography to show systolic expansion of the right atrium, the superior vena cava or even the liver (although such may be difficult to distinguish from transmitted pulsations). In general, the radiologist may suspect the presence of tricuspid insufficiency when marked enlargement of the right atrium accompanies rheumatic mitral stenosis. When roentgenologic evidence of advanced mitral stenosis exists without evidence of pulmonary vascular congestion, the diagnosis may be entertained. In such cases, the clinical diagnosis is usually readily apparent.

The present report is concerned with 12 patients with tricuspid insufficiency who were studied by both angiocardiography* and cardiac catheterization. All of these patients had chronic rheumatic mitral stenosis, all had auricular fibrillation and several were studied preliminary to mitral valve surgery. (Tricuspid insufficiency is not necessarily regarded as a contraindication to mitral commissurotomy.) The clinical diagnosis of tricuspid insufficiency was made in 6 of the 12 patients. In every case, the diagnosis was established at cardiac catheterization.

The recording of pressure curves from the interior of the right atrium by means of an intracardiac catheter constitutes the most accurate and reliable means of demon-

* Most of the angiocardiograms were performed using urokon sodium 70 per cent as the contrast agent. At this institution, urokon has been used for angiocardiographic purposes in 393 patients, 680 injections have been given. This contrast agent appears to possess a certain advantage in that, while equivalent to the other agents from the roentgenographic point of view and while as safe a drug from the point of view of toxicity, it seems to produce milder subjective symptoms in the patient undergoing angiocardiography.

* From the Department of Radiology and the Cardiopulmonary Laboratory of The New York Hospital—Cornell Medical Center, New York, New York. Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23-26, 1952.

† This investigation was aided by grants from the Mallinckrodt Chemical Works and the New York Heart Association.

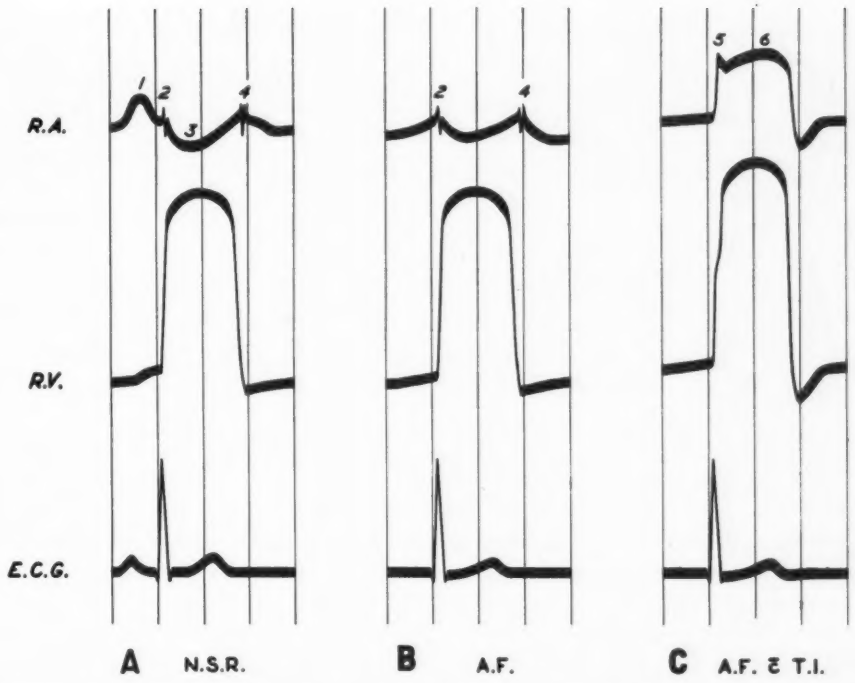

Fig. 1. Representative pressure tracings similar to those obtained at cardiac catheterization. *Upper curve*, right atrium; *middle*, right ventricle; *lower*, electrocardiogram. Normal curves are contrasted with those in auricular fibrillation and tricuspid insufficiency (with fibrillation). The high atrial plateau (6) is produced by insufficiency of the tricuspid valve. See text for further discussion.

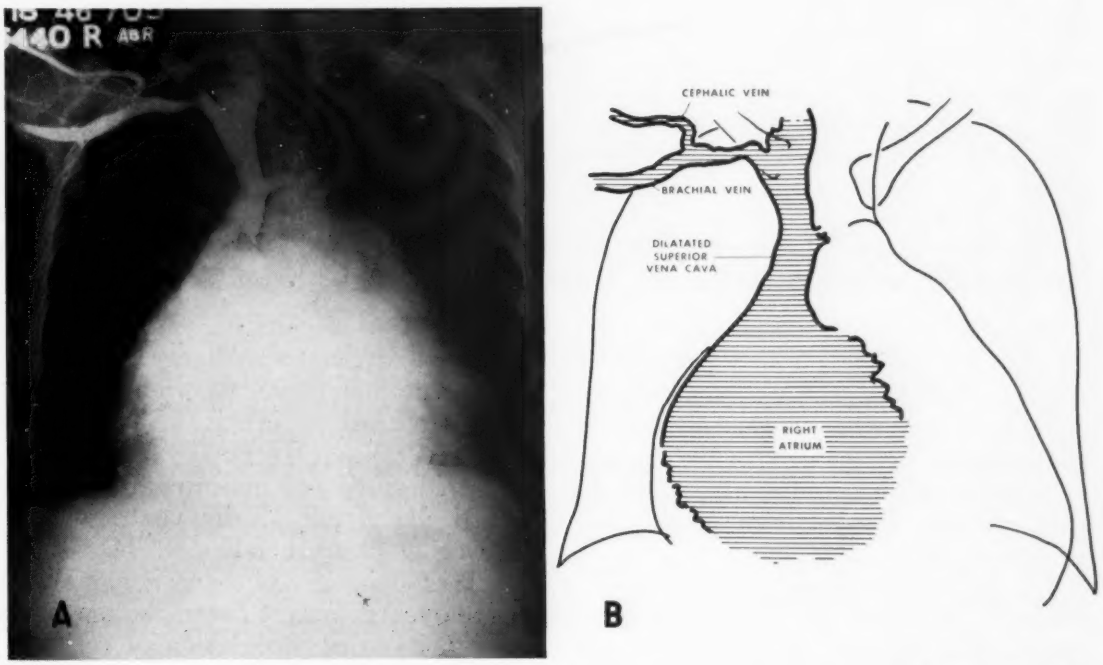

Fig. 2. (*A*) and (*B*) Tricuspid insufficiency. Angiocardiogram demonstrates enormous enlargement of the right atrium and the superior vena cava. (Reproduced by permission from Dotter, C. T., and Steinberg, I. Angiocardiography. Paul B. Hoeber, Inc., New York, 1951.)

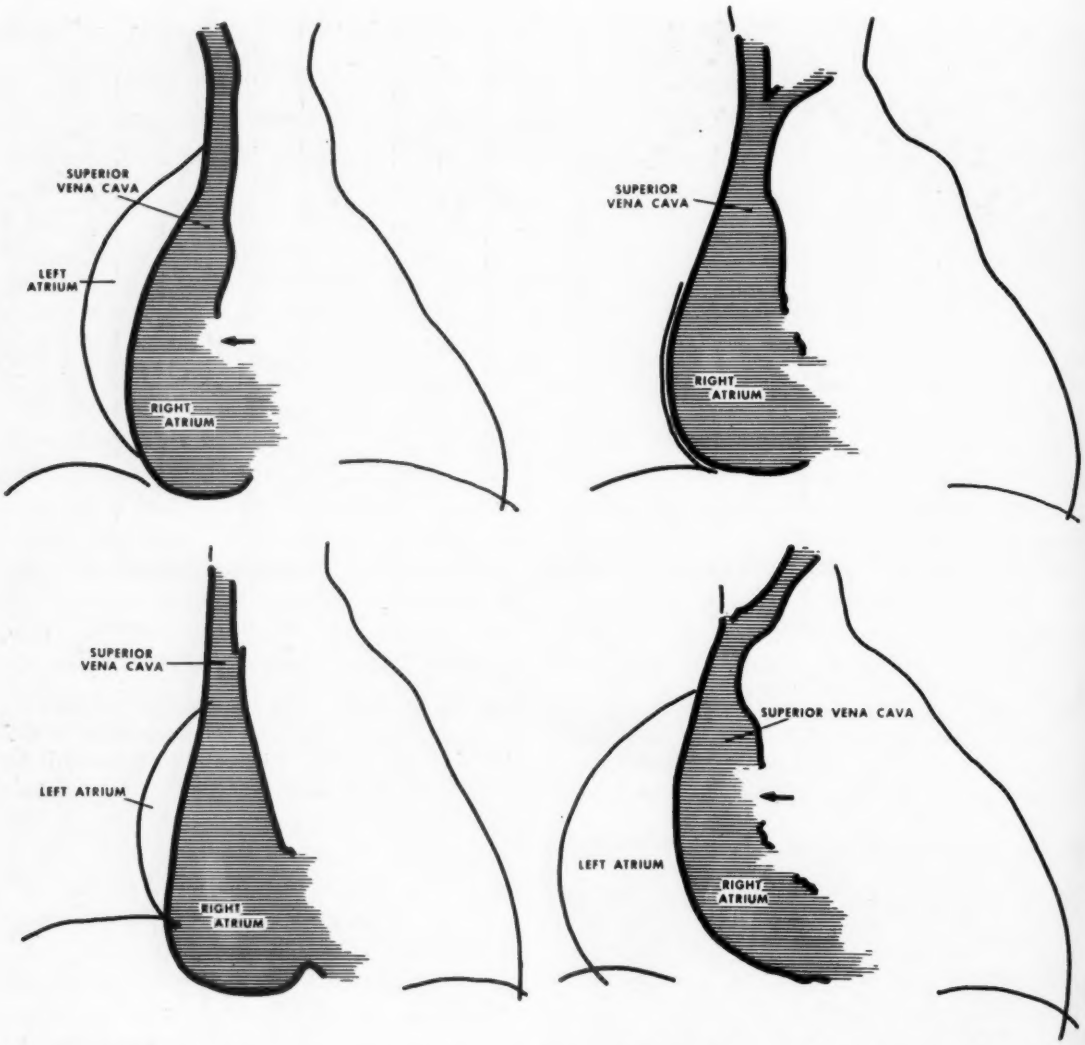

Fig. 3. Angiocardiographic configuration in 4 cases of tricuspid insufficiency. Tracings reveal enlargement of the superior vena cava and right atrium. Two cases show irregularity of filling suggesting regurgitation (arrows).

strating physiological insufficiency of the tricuspid valve.[3] Catheterization surpasses autopsy examination in this respect, for, while organic involvement of the tricuspid valve is revealed at postmortem examination, relative tricuspid incompetency may go unnoticed.

The right atrial pressure curve typical of tricuspid insufficiency is diagrammatically presented in Figure 1. A normal atrial pressure tracing and one from a fibrillating atrium but with a competent valve are presented for comparison as are right ventricular and electrocardiographic tracings. In the normal curve, shown at *A*, right atrial contraction (1) is followed by a vibration (2) that is set up by closure of the tricuspid valve and indicates the onset of ventricular systole. During ventricular systole atrial pressure falls (3). This is the result of elongation of the atrium produced by the ventricle as it contracts downward toward its apex. Conclusion of systole is accompanied by opening of the tricuspid valve which may give rise to another small vibration (4). When the tricuspid valve is

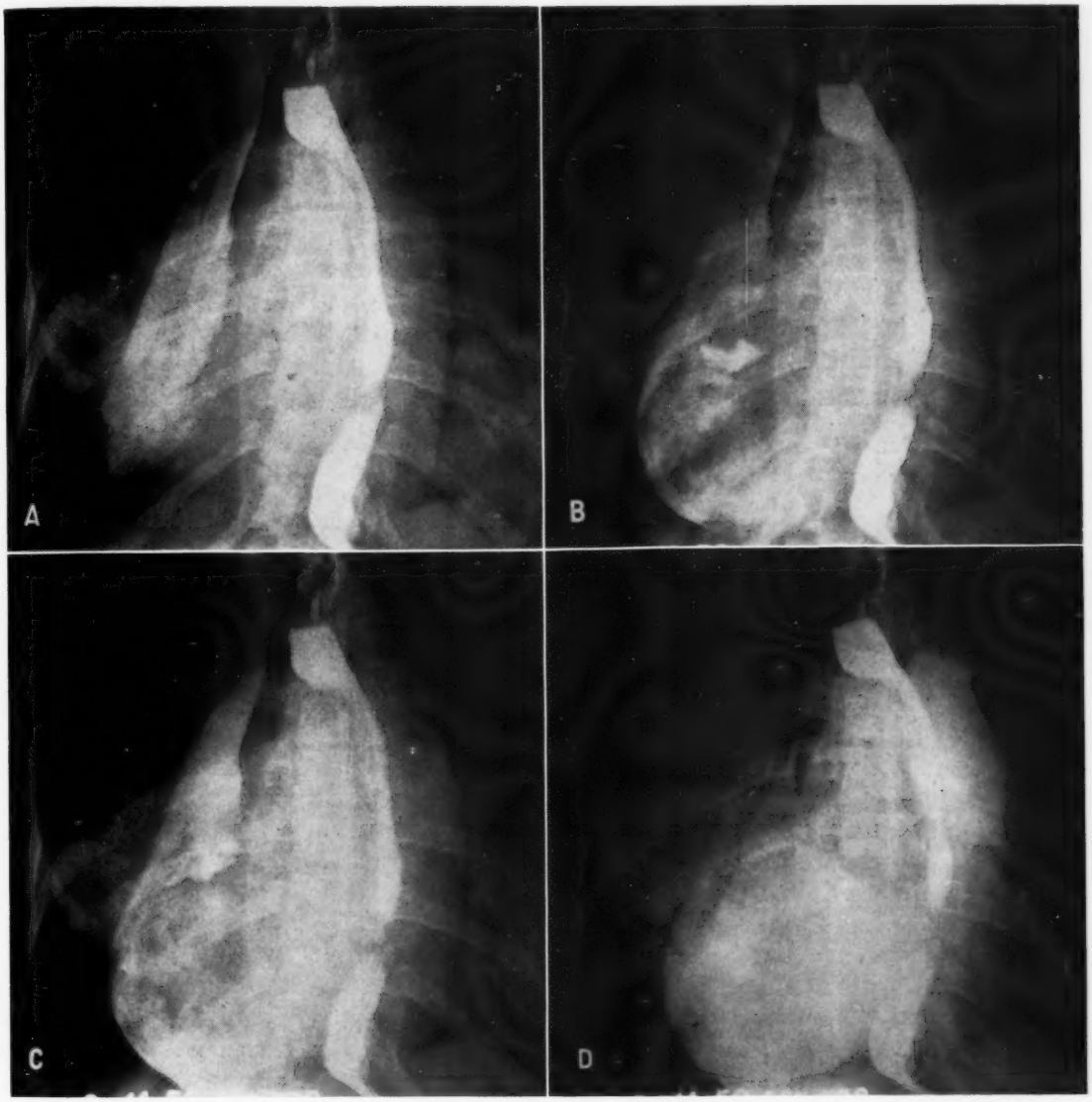

Fig. 4. (*A*) (*B*) (*C*) (*D*) Tricuspid insufficiency. Serial studies of right atrial filling reveal a defect in contrast substance within the enlarged right atrium. This changed in appearance from film to film and therefore could not represent a solid mass. The appearance resulted from a jet of blood passing backwards from the right ventricle through the insufficient tricuspid valve.

insufficient, as is shown at Figure 1*C*, the most conspicuous change in right atrial pressure is an absence of pressure decrease during ventricular systole. In its place, there occurs a definite increase of atrial pressure (5) that is sustained throughout the period of ventricular contraction (6). It is due to regurgitation of blood from the ventricle into the atrium through the insufficient valve. Such a regurgitant pressure wave usually assumes a "peak-plateau" pattern[3] and has been observed to attain a maximum of 31 mm. Hg. The height of the pressure wave depends partly on the size of the persistent orifice of the closed tricuspid valve.

Angiocardiography in tricuspid insufficiency reveals dilatation of the superior vena cava and the right atrium.[4] In advanced cases this may be striking (Fig. 2).

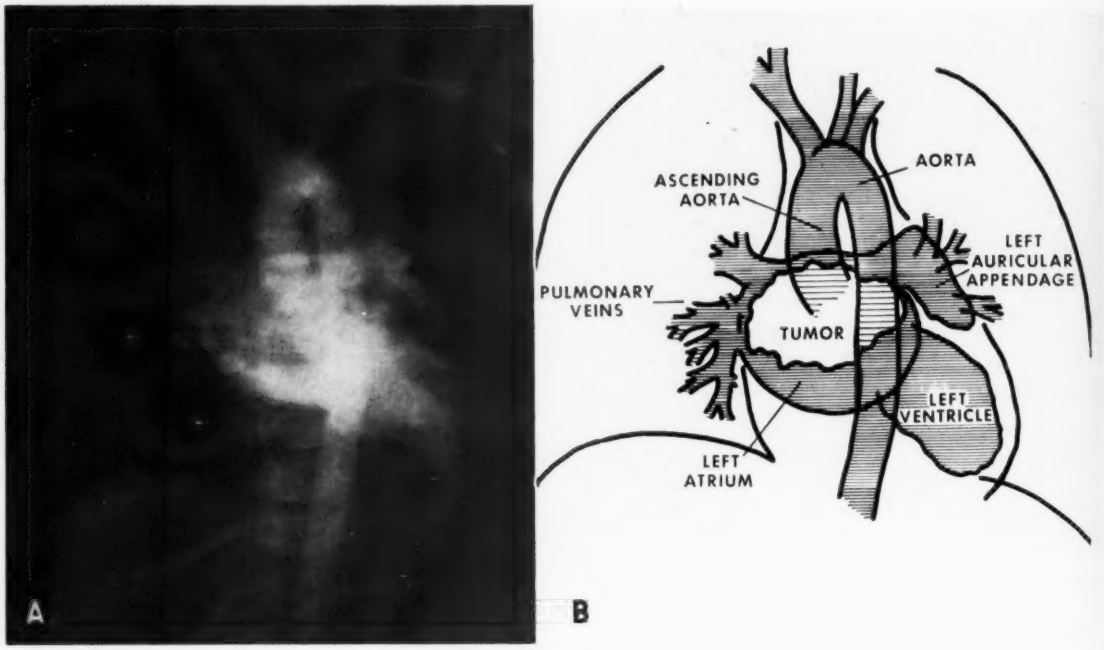

FIG. 5. (*A*) and (*B*) Intra-atrial myxoma. Angiocardiogram at 7.0 seconds shows filling of left heart and aorta. The filling defect in the left atrium was interpreted as representing a myxoma, a diagnosis later confirmed at operation.[7]

Measurement of the width of the superior vena cava in the 12 patients of this series ranged from 18 to 37 mm. and averaged 25.9 mm., approximately double the normal figures.[10] There is frequently a localized dilatation of the terminal portion of the superior vena cava just before it joins with the right atrium. This, coupled with marked enlargement of the atrium, makes the point of separation of the two structures difficult to identify. The right atrium often seems to enlarge at the expense of the superior vena cava (Fig. 3).

Of interest is an uncommon but direct angiocardiographic demonstration of the regurgitant stream in tricuspid insufficiency. If serial films are made during the period of early right atrial opacification (prior to entry of contrast agent into the right ventricle), there will occasionally be seen a filling defect in the otherwise opacified atrium. This presents irregular, inconstant borders and looks like what it actually is, a swirling jet of regurgitated unopacified right ventricular blood (Fig. 4). The jet should be inconstant in its outline in order to allow the differentiation of tricuspid insufficiency from irregularity of right atrial filling without regurgitation or an intra-atrial mass. These criteria were applicable in 2 of the 12 patients reported here while suggestive findings were noted in 3 other patients. In 4 other instances the angiocardiograms showed irregularities of right atrial filling, which were not judged to be diagnostic in character. The jet sign was observed only in cases where the clinical diagnosis could be made and therefore cannot be regarded as an important diagnostic aid. Although its presence may be regarded as strong evidence of tricuspid insufficiency, its absence does not exclude that diagnosis. Cinefluorography[9] could be expected to demonstrate this sign of tricuspid insufficiency more dramatically and with greater regularity than angiocardiography. A similar sign has been of value in the diagnosis of patent ductus arteriosus[6] and aortic septal defect[5] wherein nonopacified aortic blood produces filling defects in the pulmonary artery.

Filling defects in the right atrium due to

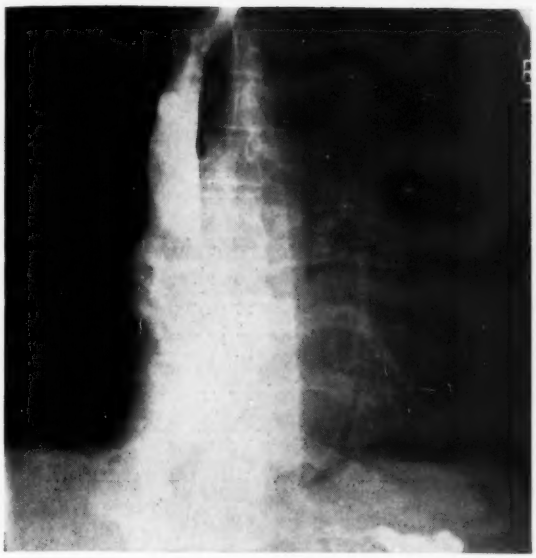

Fig. 6. Tricuspid insufficiency. Angiocardiogram (University of Pennsylvania Hospital) shows a defect in the lateral portion of the right atrium (the wall of which has been retouched). Tricuspid insufficiency instead of the suspected tumor was encountered at exploratory operation. (Patient of Dr. Joseph A. Wagner of the University of Pennsylvania Hospital.)

tricuspid insufficiency must be distinguished from those resulting from intra-atrial tumors or thrombi. In a proved case of myxoma of the left atrium studied angiocardiographically[7] the filling defect produced by the tumor was constant of contour in several films (Fig. 5). In contrast, a patient (seen at another hospital) was subjected to thoracotomy when angiocardiography showed a filling defect in the right atrium (Fig. 6). Tricuspid insufficiency rather than the suspected tumor was found.

SUMMARY

Tricuspid insufficiency is commonly associated with mitral stenosis of a degree sufficient to warrant consideration of mitral commissurotomy. Cardiac catheterization offers the most accurate means of establishing the diagnosis. Angiocardiography reveals dilatation of the superior vena cava and the right atrium and occasionally demonstrates a filling defect in films exposed during early opacification of the right atrium. This is due to regurgitation of nonopacified right ventricular blood through the incompetent tricuspid valve. Multiple exposure studies facilitate the differentiation of this finding from changes which are the result of tumor or thrombus within the right atrium.

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DISCUSSION

Dr. R. Parker Allen, Denver, Colorado. Dr. Dotter again has presented us with some

diagnostic criteria in the field of cardiac roentgenology. All of us have benefited from the many contributions already made by his group in angiocardiography, and also in cardiac catheterization. The observations set forth today have been confirmed several times in our small clinic. Perhaps I can best complement Dr. Dotter's statement by showing a few of these examples.

(Slide) This slide shows a case of mitral stenosis in which tricuspid insufficiency was found to be present. This is the electrocardiogram. This is the tracing from the right auricle, and this is a brachial artery tracing which helps to time the systole as well as does the electrocardiogram.

You will note that there are many irregular premature contractions here, and each of those has a peak which is much higher than the normal contractions, that is, the abnormal contractions set up in the right auricle by the insufficient valve.

This is a more regular tracing with just one premature contraction, which shows again the regurgitation to a better degree than the rest of the tracing.

(Slide) This is an angiocardiogram which was done at Fitzsimons General Hospital in Denver some time ago, at which time it was thought that either a tumor of the wall of the right auricle (as Dr. Dotter has suggested) or a thrombus in the right auricular chamber was present. This first film shows a fairly good filling of the right atrium, with perhaps a little irregularity along here.

(Slide) Here we have the sign which Dr. Dotter has described so nicely in his paper, and I think it shows here very well.

(Slide) Back to the normal appearance again.

Those three films were taken in sequence on a rapid film changer, showing that the mass was not a constant one. We were not sure at the time whether it was constant or inconstant, that is, whether we got more filling here which obscured the mass that might still be present.

In the light of Dr. Dotter's contribution, I think we can feel quite certain that this represents a nice example of tricuspid regurgitation.

Cardiac diagnosis remains difficult at best. Just as many of us have been surprised to learn how much the stethoscope in our own ears may aid our fluoroscopy, so may catheterization data help us to interpret our angiocardiograms. This is especially true when we become an integral part of the catheterization team, which I believe we all should become in those places where we may.

Thank you very much.

DR. DOTTER (closing). I am grateful to Dr. Allen. He has added to the value and interest of our report by showing a case which beautifully demonstrates the "jet" sign we have just described to you.

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THORACIC RENAL ECTOPIA*

By H. STEPHEN WEENS, M.D., *and* M. HARLAN JOHNSTON, M.D.†
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RENAL ectopia is a rather frequent condition which according to position of the displaced kidney may be classified as pelvic, iliac, abdominal, or thoracic.[8] Campbell,[3] on reviewing 47,477 autopsy cases from the literature, observed 72 cases of renal ectopia, an incidence of 1 in 660. Among the several variants of this anomaly, the thoracic type (high ectopia) may be considered as rare. Most reports concerning the latter anomaly are to be found in autopsy descriptions of stillborns and infants, usually associated with other severe malformations such as those of the gastrointestinal tract.[3,5,9]

More recently, however, a very small number of cases has been recorded in the clinical literature in which thoracic renal ectopia was either discovered unsuspectedly at operation,[1,6] or diagnosed during life with the aid of roentgen studies.[4,7] Since the proper recognition of this anomaly is of considerable importance in the differential diagnosis of a space occupying lesion of the chest, it was considered worth while to describe the following case in which a thoracic mass could be identified as an ectopic kidney.

CASE REPORT

G.D., a thirty-three year old colored male, was admitted to Grady Memorial Hospital on March 6, 1951, in a semi-comatose condition. Ten days prior to admission, he developed swelling in the region of the right parotid gland which had subsided completely on admission.

The patient awakened his family on the day of admission by extreme restlessness and incoherent speech. Shortly after admission to the Emergency Clinic, he had a grand mal seizure, lasting about two minutes, followed by a similar attack thirty minutes later lasting for a similar period.

His past history revealed that he was treated for syphilis in 1947, receiving adequate therapy. He had a traumatic cataract removed from his right eye in 1945. Prior hospital records indicated the occurrence of petit mal seizures but none had been observed by a physician and their duration was quite vague.

Physical examination revealed a well nourished colored male, unresponsive except to painful stimuli. Neurologically, the examination was otherwise negative and no localizing signs were present. A marked hypospadias was noted. The temperature was 100°F. Pulse and blood pressure were normal. Spinal fluid studies including dynamics were normal, as were other laboratory findings.

His condition did not change during the first thirty-six hours in the hospital, but he became rational after two days. Frontal lobe tumor, central nervous system syphilis, mumps encephalitis, and bronchogenic carcinoma with cerebral metastases were considered initially in the differential diagnosis. No definite diagnosis was established prior to discharge from the hospital. He was sullen and uncooperative until several days prior to discharge, which was two two weeks later.

Roentgen Findings. A bedside roentgenogram of the chest on admission revealed a round density measuring 8.0 cm. in the left lower lung field behind the heart (Fig. 1). Roentgenoscopy showed the mass to be posterior, regressing slightly on expiration and becoming more prominent on inspiration. The mass did not appear rounded as on the initial film but appeared to have a broad base, filling the posteromedial thorax.

The possibility of the left kidney having herniated through the foramen of Bochdalek was considered and retrograde pyelography several days later confirmed the diagnosis (Fig. 2, *A* and *B*). The upper pole of the kidney was clearly demonstrated to be above the level of the diaphragm.

The patient was discharged to be studied on an out patient basis.

ANATOMIC CONSIDERATIONS

Congenital thoracic renal ectopia occurs in the region of the trigonum lumbocostale

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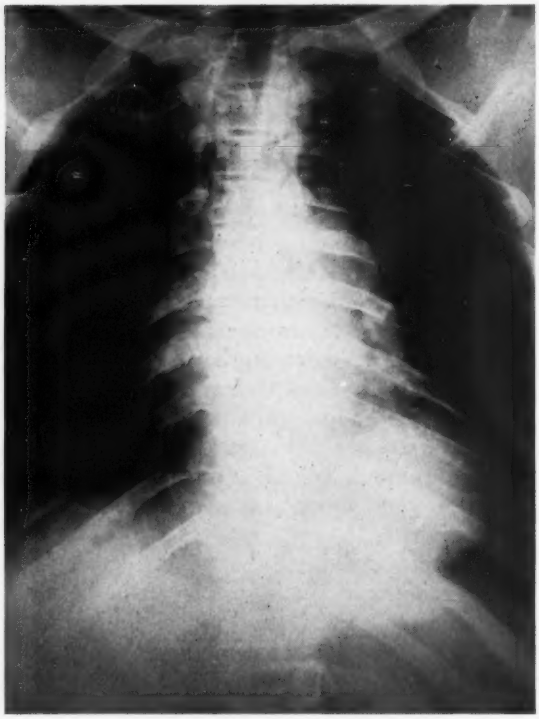

FIG. 1. Bedside roentgenogram of the chest. Note rounded mass behind the heart shadow.

of Bochdalek. A detailed description of the embryology of the diaphragm will not be attempted here. It should be emphasized, however, that the development of the diaphragm, which is closely related to the final subdivision of the celomic cavity into the pericardial, pleural, and peritoneal spaces, offers many chances for embryologic aberrations.

The diaphragm is preformed as a membranous structure by the fusion of several primordial segments. This membranous organ receives final structural support by the development of musculature which according to Bremer[2] is largely derived from the inner layers of the body wall.

The final fusion of the posterolateral and posteromedial segments of the diaphragm is accomplished by the development of the pleuroperitoneal membrane which obliterates the passage from the pleural to the peritoneal space. Bremer emphasizes the important role which the large fetal adrenal gland plays in the final closure of this communication. Embryologic aberration of

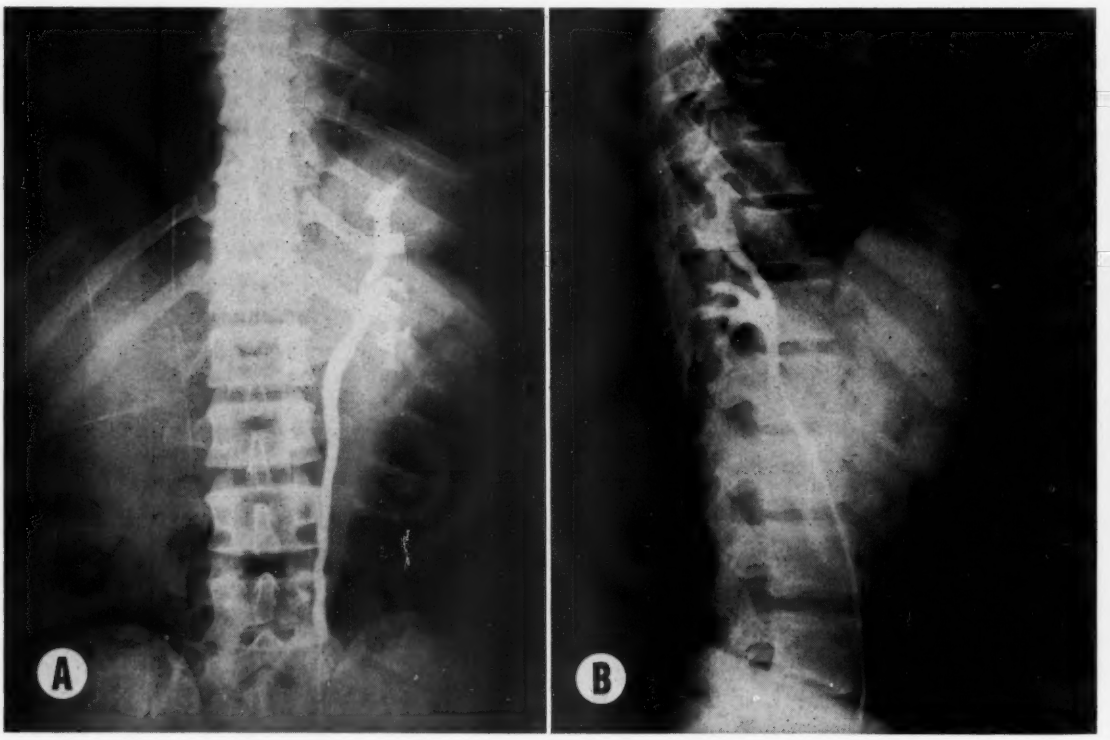

FIG. 2. Anteroposterior (*A*) and lateral (*B*) retrograde pyelograms. The upper pole of the kidney is shown above the level of the diaphragm.

this development may enhance the development of diaphragmatic hernia which in this region is relatively common and usually referred to as hernia of the foramen of Bochdalek.

It is interesting that high renal ectopia has been considered as a causative factor in defective fusion of the diaphragmatic segments. The definitive human kidney (metanephros) is situated in the region of the fetal pelvis in its early embryonic development. Subsequently an upward migration takes place with the kidney ascending to its permanent location at the level of the upper lumbar spine.

Von Mikulicz-Radecki[9] and Kleine[5] therefore postulated that an abnormally high ascent of the kidney may have prevented fusion of the posteromedial and posterolateral portions of the diaphragm, facilitating the development of diaphragmatic hernia. Other authors[4] have suggested that faulty degeneration and descent of the mesonephros may have contributed to the imperfect closure of the posterior elements of the diaphragm.

Pathologically, high renal ectopia is not only characterized by the anomalous position of the kidney but also by abnormal ureteral length, an anomalous blood supply, and failure of medial rotation. These kidneys may exhibit unusual lobulated and disc-like shapes, frequently being smaller than normal. The failure of normal medial rotation explains the presence of an anterior kidney hilus as seen on roentgen examination.

Ectopia of the kidney in this area is nearly always congenital, though cases of traumatic herniation of the kidney through the diaphragm have been reported.[1,10] The congenital type may be associated with other congenital defects of the genitourinary system. This occurrence is exhibited in our case.

ROENTGENOLOGIC ASPECTS

A broad-based thoracic mass adjacent to the posteromedial portion of the diaphragm should arouse suspicion of high renal ectopia. With proper urographic studies it should not be difficult to differentiate a thoracic kidney from pulmonary tumors, pleural tumors and fluid collections, mediastinal masses, diaphragmatic tumors, and hernias of other abdominal viscera.

On routine intravenous and retrograde pyelographic examinations, the roentgen-ray beam is directed towards the fourth lumbar vertebra. In this manner, the relation of the diaphragm and kidney becomes distorted, the high anterior segment of the diaphragm being projected above the upper pole of the ectopic kidney. Close attention should therefore be paid to the position of the kidney with reference to the spine, ribs and posterior costophrenic sulcus. In pyelograms of these cases it is advocated to center the roentgen-ray beam to the level of the diaphragm in both the anteroposterior and lateral projections, in order to obtain an undistorted view of the relationship of kidney and diaphragm.

Roentgenologically, in addition to the anomalous position of the kidney, the abnormal ureteral length, the anterior renal hilus and the abnormal shape of the kidney should be noted.

This case demonstrates the necessity of identification of this rare condition as the mass was initially implicated as being related to the clinical picture.

SUMMARY

A case of congenital thoracic renal ectopia is presented and its importance in the differential diagnosis of thoracic masses stressed. The frequency and embryology of this condition are briefly discussed. Proper roentgenographic technique in the detection of high renal ectopia is emphasized.

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PEPTIC ULCER IN THE AGED AND GASTRIC CARCINOMA IN THEIR RELATIONSHIP TO ARTERIOSCLEROSIS

A ROENTGENOLOGICAL STUDY*

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THE present investigations originated from the observation that gastric ulcer is more commonly met with in middle aged and elderly people than in the younger age groups. This experience, gained over a period of ten years in the roentgen departments of general hospitals, finds confirmation in recent surveys on the age incidence of gastric and duodenal ulcers. A medical research council report[9] (1951) on peptic ulcer states that the expectation of gastric ulcer being greatest between thirty-five and sixty-four, while the expectation of duodenal ulcer is greatest and constant between twenty and sixty-four. Besides the difference in age of onset, experimental evidence is forthcoming in support of the conception that gastric and duodenal ulcer are distinct diseases. The view has been widely accepted that supernormal secretion of acid and pepsin play an important part in the causation of duodenal ulceration, whereas no increased acidity is found in most patients with gastric ulcer. James and Pickering[6] (1949) found that the acidity of the fasting gastric contents after normal meals fell very considerably during the later part of the night in patients with gastric ulcer, but did not do so in normal people or in patients with duodenal ulcers. In spite of the increased secretion of acid and pepsin in cases of duodenal ulcer, the gastric mucosa usually shows a remarkable resistance to this potentially harmful stimulus, and a concomitant peptic lesion rarely develops in the stomach. It is, therefore, likely that a special susceptibility of the gastric mucosa is the primary cause for the development of ulceration. Local alteration or interference of blood supply are recognized causes of lowered resistance of the mucous membrane. Since arteriosclerosis is a common cause for alteration and interference of blood supply in middle aged and elderly people, it was feasible to assume that degenerative vascular lesions may play a part in the causation of gastric ulcer.

In order to find evidence for this conception, a reliable method had to be found, which could determine the presence or absence of advanced arteriosclerosis during life. It was held that roentgenographic examination of the abdominal aorta would fulfill these requirements, since according to statistical observations, this vessel is most frequently and extensively involved in general arteriosclerosis. Furthermore, the stomach derives its vascular supply from the celiac axis, a branch of the abdominal aorta. The first results of these investigations were recorded in a preliminary communication (Elkeles,[3] 1949), in which a total of 184 patients was examined. The present investigations were carried out on 732 patients over fifty years of age and comprise 116 gastric ulcers, 190 duodenal ulcers, 70 gastric carcinomas and 356 control cases. The latter were chosen at random from patients with no detectable pathology of the stomach or duodenum. The diagnosis of gastric and duodenal cases was confirmed either by operation, postmortem or by follow-up examinations.

Calcification of the abdominal aorta can often be visualized at barium meal examination with the patient erect in the right oblique position. A more reliable method,

* Presented in part at the Sixth International Congress of Radiology, London, July, 1950.

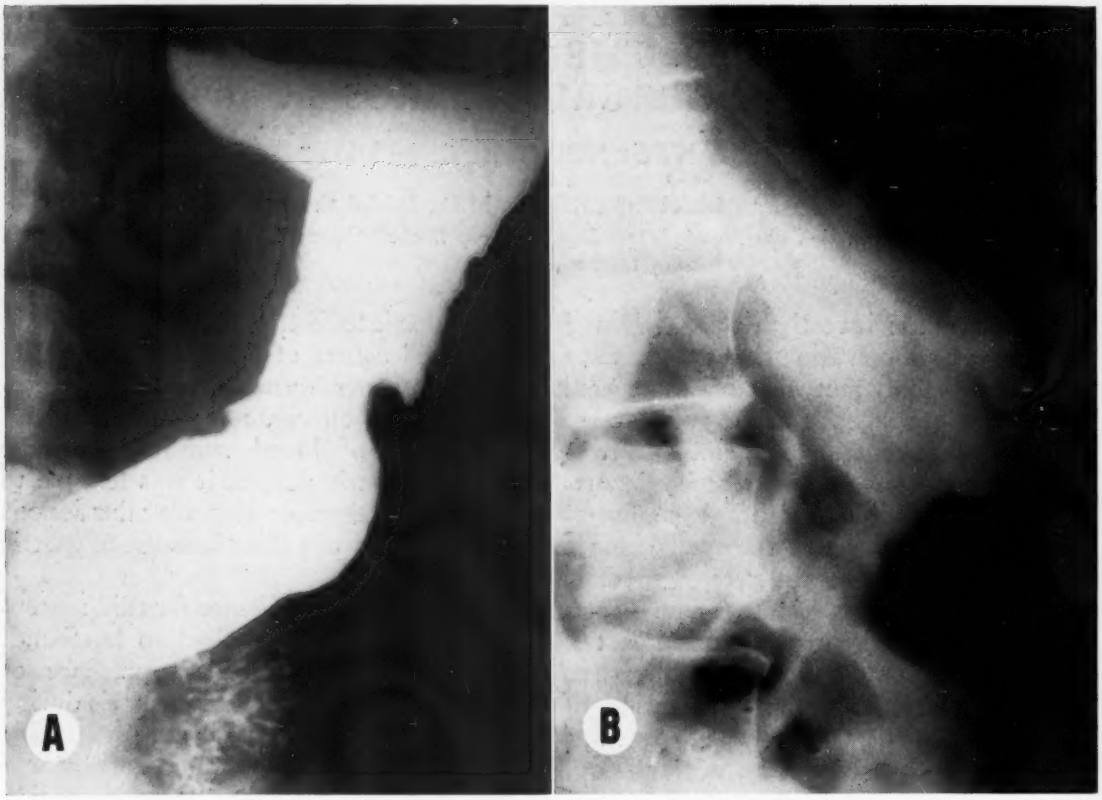

Fig. 1. Case 1. Male, aged sixty-seven. (*A*) Malignant ulcer near incisura angularis, proved at operation. (*B*) Lateral view, no calcification of abdominal aorta.

however, is by taking roentgenograms with the Potter-Bucky grid, the patient lying on his left side, and the tube centered between second and third lumbar vertebrae. Although the method is simple, the interpretation requires good quality roentgenograms, particularly in obese patients, Sclerosis of the anterior margins of lumbar vertebrae, marginal osteophytes and calcified glands may be mistaken for calcification of the abdominal aorta. In order to give some indication as to the extent of calcification in the abdominal aorta, the lesions have roughly been classified as: o, +, ++, +++. The following roengenograms are examples of the various types of calcification met with in these investigations. They also demonstrate the difficulty of the differentiation between malignant and benign ulceration.

Figure 1, *A* and *B*, Case 1, show an ulcer near the angular incisura in a male sixty-seven years of age. No meniscus sign could be demonstrated, but the abdominal aorta shows no trace of calcification. Operation proved the ulcer to be malignant with large secondaries in the liver.

Figure 2, *A* and *B*, Case 11, are roentgenograms of a male, fifty years of age, who complained of gastric pain one hour after meals and occasional vomiting. He had lost considerably in weight over the last three months. No free hydrochloric acid was present at test meal examination. A doubtful mass could be felt in the left hypogastrium. Barium meal examination shows a giant ulcer high up at the lesser curvature and thin linear calcification along the medial wall of the abdominal aorta approximately 4 cm. in length (+). Operation revealed an unusually large benign ulcer. The ulcer crater had excavated the left lobe of the liver to a depth of 1½ inches, and the diameter of the opening in the liver was about 2 inches across. The pancreas was also involved over a similar sized area.

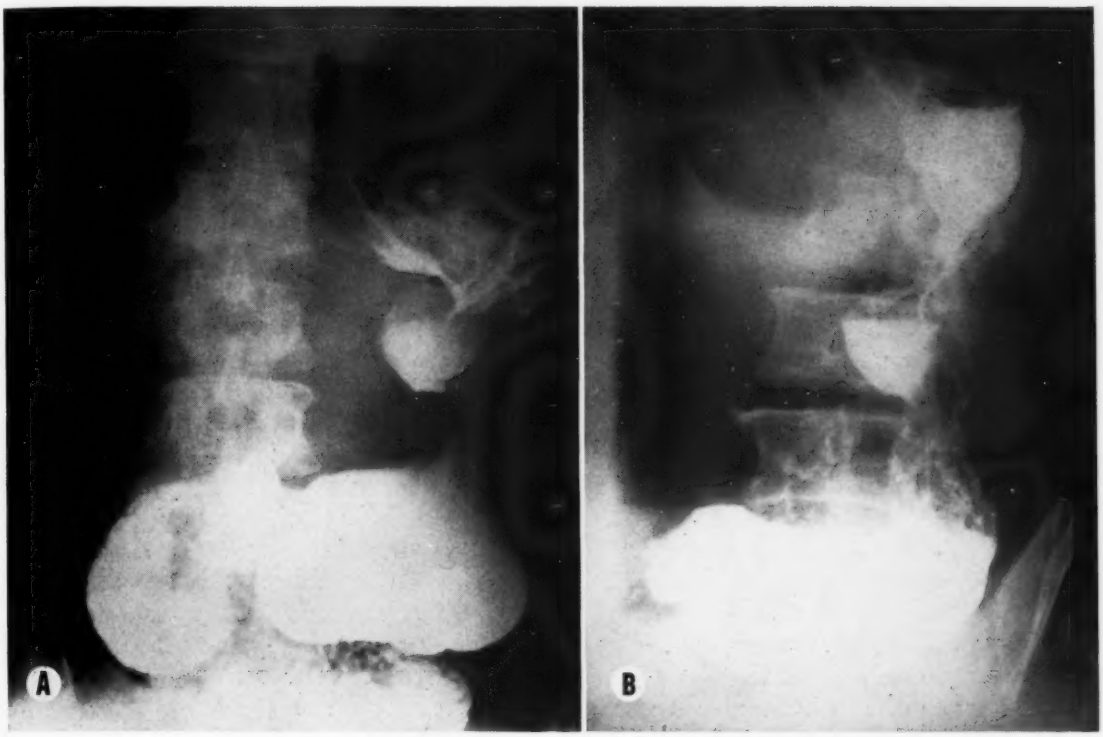

Fig. 2. Case II. Male, aged fifty. (*A*) Giant ulcer high up at the lesser curvature, found to be benign at operation. (*B*) Lateral view shows linear calcification of abdominal aorta approximately 4 cm. in length (+).

Figure 3, *A* and *B*, Case III, shows a giant ulcer at the lesser curvature in a female, sixty-seven years old, and calcification of the medial and lateral walls of the abdominal aorta of 4 cm. (++). On clinical grounds malignancy was suspected. Operation, however, revealed a large benign ulcer.

Cases II and III are only examples of a number of observations, which prove that the large size of a gastric ulcer is not a reliable sign for malignancy.

Figure 4, *A* and *B*, Case IV, are roentgenograms of a male, aged seventy, showing medium sized lesser curvature ulcer. The abdominal aorta shows calcification almost in its whole length (+++). Control examinations over several months and clinical course proved the ulcer to be benign.

Tables I, II, III and IV show the results of the present investigations.

DISCUSSION

Already in the past a number of pathologists have emphasized a causative relationship of general arteriosclerosis to gastric ulcer (Hauser,[5] 1883, Ophüls,[7] 1913, Hart,[4] 1919, and others). This conception has not yet found wide acceptance with clinicians. The reason for this may be that so far no distinction has been made between peptic ulcers with their onset in early adult life and those developing past middle age. The present investigations reveal two outstanding results, namely, the very frequent association of gastric ulcer with arteriosclerosis and the extremely rare occurrence of calcified atheroma in the abdominal aorta in patients with gastric carcinoma. Before discussing these findings as to their significance for the roentgenological differential diagnosis between benign gastric ulcer and carcinoma of the stomach, the results of the investigations with regard to the pathogenesis of peptic ulcer in the aged will be examined first.

Comparing the percentage figures of calcifications in the gastric ulcer series (75

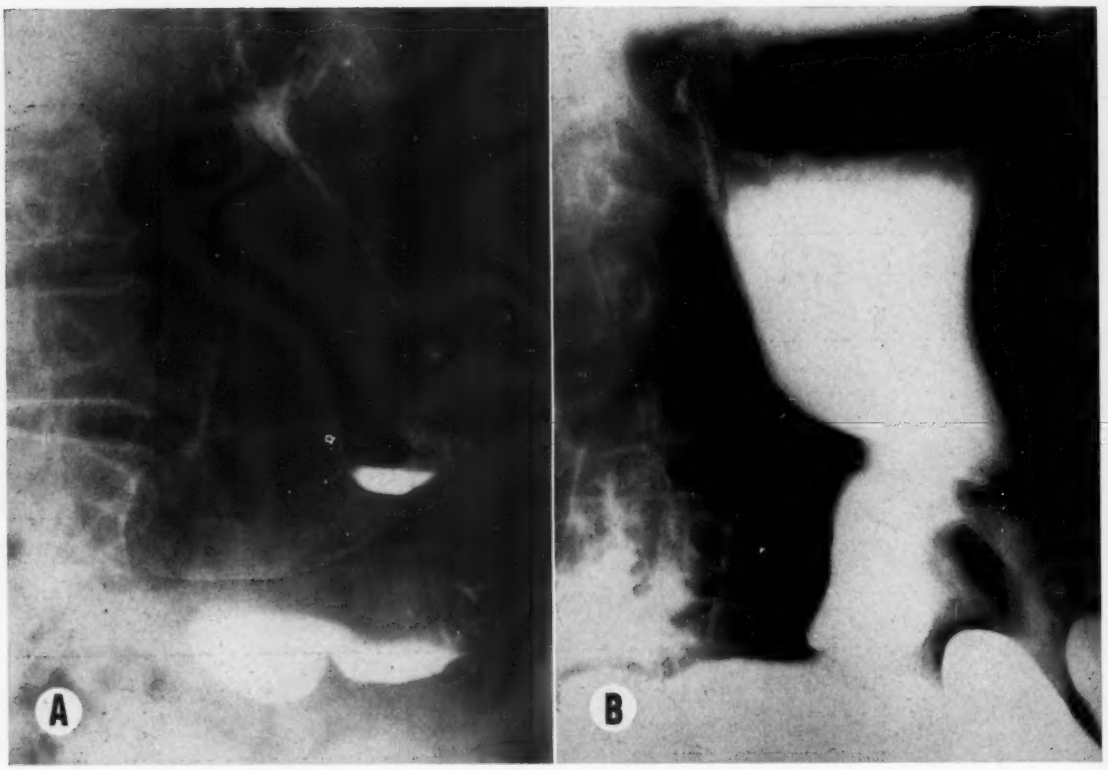

Fig. 3. Case III. Female, aged sixty-seven. (*A*) Right oblique view reveals giant ulcer after first barium swallow and dense calcification of aortic wall 4 cm. in length opposite the ulcer (++). (*B*) Posteroanterior roentgenogram of the stomach shows the huge ulcer crater filled with barium. Ulcer proved to be benign at operation.

per cent) with those of the duodenal ulcer (34.2 per cent) and control cases (32 per cent), it is evident that the frequent association of gastric ulcer with arteriosclerosis cannot be attributed to mere coincidence. Arteriosclerotic vessels are often seen in the close vicinity of chronic gastric ulcers during operation and at postmortem examination. Some authors do not accept this finding as proof for the arteriosclerotic pathogenesis of these ulcers, but rather attribute their presence to long standing inflammatory changes. It is, however, most unlikely that chronic inflammatory changes of a gastric ulcer could produce atheroma of the abdominal aorta. Calcifications of arteries may be asymptomatic and do not necessarily lead to arterial obstruction, but they are often the cause of slowing down the arterial flow. Thus the conditions are set for a disturbance of balance between blood supply and demand, as it occurs in intermittent claudication and in angina of effort. In analogy to these conditions a disturbance of balance between blood supply and demand may occur in the stomach, resulting in damage to the mucous membrane and subsequent ulceration.

Roentgenologically gastric ulcers in the aged are often large, and giant ulcers are almost exclusively found in elderly individuals. Furthermore, with advancing years the location of the ulcer is usually farther away from the pylorus than those met with in the younger age groups.

The investigations reveal that the frequency of calcification in the abdominal aorta increases with advancing years, but it should be emphasized that in the age group fifty to sixty only 17 per cent of the control cases and 21.7 per cent of patients with duodenal ulcer show calcification of the abdominal aorta. Thus the high incidence of calcification (64 per cent) in patients

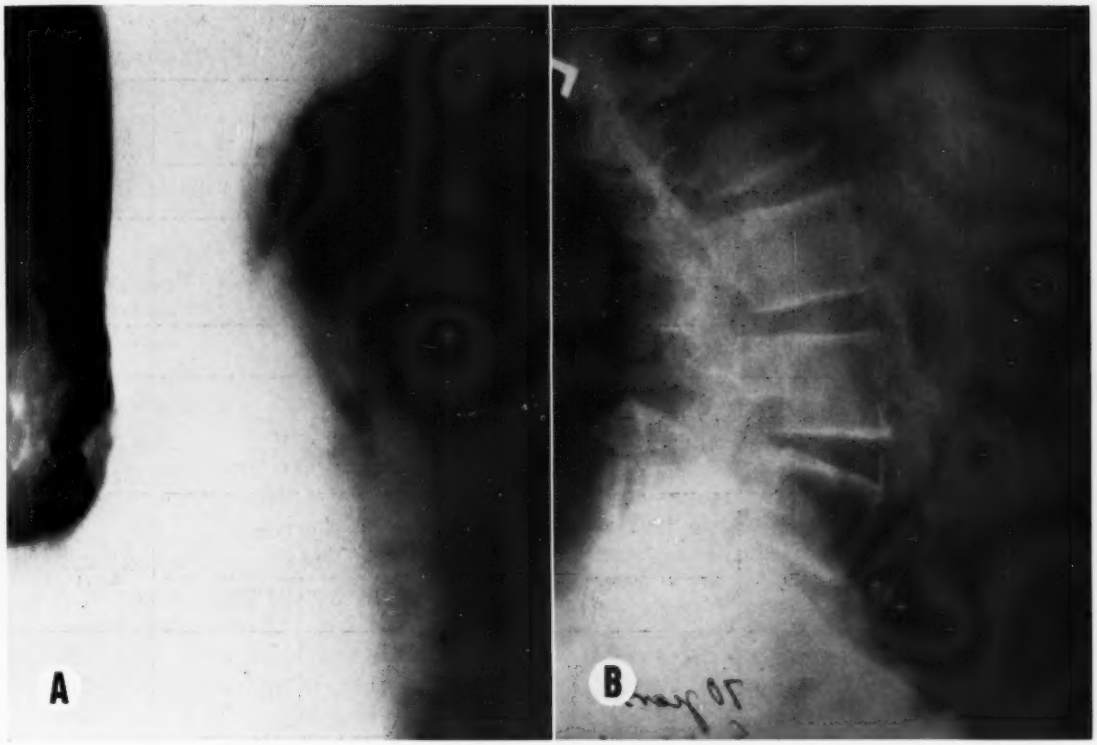

Fig. 4. Case iv. Male, aged seventy. (*A*) Healing lesser curvature ulcer. (*B*) Lateral view shows extensive calcification of abdominal aorta (+++).

with gastric ulcer of the same age group is of particular significance, and is in support of the conception that arteriosclerosis plays an important part in the pathogenesis of gastric ulcer in the aged.

The duodenal ulcer series shows only a slightly higher percentage of calcification of the abdominal aorta than the control cases. This finding may be explained by the observation that many of the duodenal ulcers met with in the older age groups are of long duration, usually dating back to periods of life in which arteriosclerosis is unlikely to have played a part in their pathogenesis. However, some duodenal ulcers have their onset in later life, and in these a causative relationship to arteriosclerosis also seems likely. Roentgenologically this type of duodenal ulcer is often large and may lack the spaxticity of the duodenal cap, so frequently seen in duodenal ulcers of the younger age groups.

The rare occurrence of calcification in the abdominal aorta in gastric carcinoma (4.3 per cent) is of particular interest. In the vast literature on cancer only few reports on the relationship of cancer to arteriosclerosis are to be found. However, Busch[1] (1923), Casper[2] (1932), Sjövall and Wihman[8] (1934), who investigated this problem on postmortem material, emphasize that severe arteriosclerosis is rarely met with in cancer cases. The striking discrepancy between benign gastric ulcer and carcinoma of the stomach in their relationship to advanced arteriosclerosis provides a valuable roentgenological sign for the often difficult differential diagnosis of ulcerative lesions of the stomach. No roentgenological sign can be considered as infallible, but the present investigations suggest that calcification of the abdominal aorta, which is clearly demonstrable on roentgenograms, is evidence in favor of benign gastric ulceration, whereas absence of calcifications in doubtful cases should raise suspicion of malignancy.

TABLE I

GASTRIC ULCER

Age	Number of Cases	Degree of Calcification of Abdominal Aorta on Roentgenograms				Per Cent of Calcification
		o	+	++	+++	
50–60	59	21	11	8	19	64
61–70	50	8	5	20	17	84
71–80	7	o	o	o	7	100
Total Number	116					

Calcification = 75 per cent.

TABLE II

GASTRIC CARCINOMA

Age	Number of Cases	Degree of Calcification of Abdominal Aorta on Roentgenograms				Per Cent of Calcification
		o	+	++	+++	
50–60	28	28	o	o	o	o
61–70	28	27	o	1	o	3.6
71–80	14	12	2	o	o	14.3
Total Number	70					

Calcification = 4.3 per cent.

TABLE III

DUODENAL ULCER

Age	Number of Cases	Degree of Calcification of Abdominal Aorta on Roentgenograms				Per Cent of Calcification
		o	+	++	+++	
50–60	92	72	13	4	3	21.7
61–70	80	48	17	10	5	40
71–80	18	5	4	6	3	70.2
Total Number	190					

Calcification = 34.2 per cent.

TABLE IV

CONTROLS

Age	Number of Cases	Degree of Calcification of Abdominal Aorta on Roentgenograms				Per Cent of Calcification
		o	+	++	+++	
50–60	175	145	12	10	8	17.1
61–70	127	77	15	17	18	39.3
71–80	54	19	8	9	18	61.1
Total Number	356					

Calcification = 32.3 per cent.

SUMMARY

1. Peptic ulcer in the aged and carcinoma of the stomach in their relationship to advanced arteriosclerosis have been investigated by roentgenographic examination of the abdominal aorta.

2. The investigations were carried out on 732 patients over fifty years of age, comprising 116 cases of gastric ulcer, 70 of gastric carcinoma, 190 of duodenal ulcer and 356 controls.

3. Benign gastric ulcers show by far the highest incidence of calcification of the abdominal aorta: 75 per cent, duodenal ulcers: 34.2 per cent, control cases: 32.3 per cent. A surprisingly low percentage is found in gastric carcinoma: 4.3 per cent.

4. The significance of these findings with regard to the pathogenesis of gastric ulcer in the aged is discussed.

5. The frequent association of gastric ulcer with calcification of the abdominal aorta and its rare occurrence in gastric carcinoma may be of value for the roentgenological differential diagnosis between benign and malignant ulceration of the stomach.

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GAS IN INTERVERTEBRAL DISCS*

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SINCE Schmorl's studies in the early 1930's considerable interest has been centered on intervertebral discs, and particularly on herniated discs. The so-called vacuum phenomenon in intervertebral discs has been recognized more recently. It is shown roentgenographically as an area of decreased density, more easily visible on the lateral view, which is often irregular in shape, and may be faint and poorly outlined. It is located in various areas of the intervertebral disc, but is most common in the central portion (Fig. 1 and 2). If there is asymmetrical narrowing of the disc, the decreased density is often found at the narrowest portion (Fig. 3).

FIG. 1. Gas in intervertebral discs is indicated by arrows. Associated findings are narrowing, spurring, and eburnation.

FIG. 2. Gas in the disc is indicated by the arrow.

Knutsson[4] believes that cracks develop in discs, forming irregular areas of decreased density, which are pathognomonic of disc degeneration. I suggest that these areas of decreased density in degenerating discs contain gas from surrounding fluids which have been vaporized as the result of a partial vacuum. Fuiks and Grayson[1] state that gas in joint spaces has been found to be composed of oxygen, carbon dioxide

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Fig. 3. Gas is seen at the narrowest portion of the disc.

and nitrogen in proportions similar to those in circulating blood.

Other findings usually associated with gas in discs are narrowing of intervertebral spaces and intervertebral foramens, eburnation of adjacent portions of vertebral bodies, and spurring of adjacent margins of these bodies. Occasionally one will also notice retroposition of the vertebra immediately above the affected disc.

STATISTICAL STUDY OF 2,419 ROENTGEN EXAMINATIONS OF THE LUMBOSACRAL SPINE

Only a few cases of the vacuum phenomenon in discs are reported in the literature. In the belief that this is another of those conditions which we frequently look at but seldom see, I have determined the incidence of this condition in a group of veterans, many of whom were applying for disability benefits which were not service-connected. No attempt has been made to correlate the roentgen findings with symptoms or other clinical data.

Incidence, Distribution, and Amouut of Gas in Discs. In the roentgen department of the Veterans Administration Regional Office in Winston-Salem, North Carolina, a total of 2,419 examinations of the lumbosacral spine were made between January 6, 1949, and September 25, 1950. The sole reason for selecting this group of cases for study was that during this time accurate records were kept on the occurrence of gas in intervertebral discs. In this series 49 patients were found to have gas in at least one disc in the lumbosacral region—an incidence of 2.026 per cent. Ten of these patients had gas in more than one disc in this area, so that a total of 61 discs were involved.* Table 1 shows the distribution of gas in discs, both in the cases where a single disc was involved and in those with involvement of two or more discs.

Table I

GAS IN INTERVERTEBRAL DISCS

Location of Disc	Single Disc Involved	Multiple Discs Involved	Total
T12–L1	0	2	2
L1–2	1	2	2
L2–3	4	3	7
L3–4	3	3	6
L4–5	11	8	19
L5–S1	18	5	23
L5–6	2	0	2
Total	39	23 (10 cases)	61 (49 cases)

Nineteen discs between the fourth and fifth lumbar bodies and two between the fifth and sixth lumbar bodies contained gas in this series. Since these two discs are functionally comparable, the occurrence

* Many of these 49 patients also had gas in discs of the thoracic and cervical spine, but since the total number of examinations was not counted the incidence in these areas is not available. Gas was found once in each of the following discs: C5-6, T6-7, T8-9, T9-10, T10-11, and T11-12. When the entire spine was included, 11 patients had involvement of more than one disc, with 7 showing gas in two discs, 2 in three discs, 1 in four discs, and 1 with gas in five discs.

FIG. 4. Eburnation is on the left in the third and fourth lumbar vertebrae and on the right in the fourth and fifth lumbar vertebrae associated with gas in the discs.

of gas here is 34.4 per cent. Twenty-three, or 37.7 per cent, of discs containing gas occurred at the space between the fifth lumbar and the first sacral vertebrae. Thus, in this series, the lower two discs accounted for 72.1 per cent of the cases of gas in intervertebral spaces of the lumbosacral spine. The high incidence of gas in these locations is roughly parallel to the distribution of herniated nuclei, and is probably due to greater stress on these two discs.

The amount of gas present in discs was very slight in 3 instances, slight in 39, slight to moderate in 1, and moderate in 18. Fuiks and Grayson[1] imply that simple hyperextension of the spine will often reveal gas in discs which would not show it otherwise. No such manipulation was carried out in this series of examinations; in fact, the hips were always flexed, and this position tends to flex the spine.

Age and Race of Patients. The average age of the 2,419 patients examined in this series was 50.5 years, the youngest being nineteen and the oldest seventy-two. The average age of the 49 patients found to have gas in discs was fifty-seven, the youngest being forty-nine and the oldest sixty-seven years of age. All the patients were males. Three of the 49 were Negroes; the race of 3 was not recorded, and the rest were white.

Associated Findings. Of the 61 discs in the lumbosacral area which contained gas, 57, or 93.5 per cent, also showed narrowing. The amount of narrowing varied from 5 to 95 per cent, the average being 51.3 per cent. An equally common finding was spurring at the margins of the vertebral bodies adjacent to the gas-containing discs. This was also present in 57 instances, being very slight in 7, slight in 20, moderate in 24,

TABLE II

EBURNATION OF VERTEBRAL BODIES ADJACENT TO DISCS CONTAINING GAS

	None	Very Slight	Slight	Moderate*	Considerable†	Total
T12–L1			2			2
L1–2				2		2
L2–3	1	1	4		1	7
L3–4			2	4		6
L4–5	2		12	3	2	19
L5–S1	2	1	14	4	2	23
L5–6			1	1		2
Total	5	2	35	14	5	61

* Involving one-fourth the thickness of the bodies.
† Involving one-half the thickness of the bodies.

TABLE III

SUMMARY OF ALL CASES OF GAS IN INTERVERTEBRAL DISCS

Age	Race	Disc	Amount of Air	Percentage Narrowing	Spurring	Eburnation	Miscellaneous Findings
55	W	L2–3	S*	85	M*	C*	Slight right convex scoliosis
59	W	L2–3	M	60	M-Adv.	S	Slight retroposition of L2 on 3, slight left convex scoliosis
55	W	L2–3	S	60	S	N	
56	W	L2–3	S	90	M	S	Air anteriorly
62	W	L3–4	M	40	M-Adv.	M	Slight right convex scoliosis, spurring on left, anterior prominence and irregularity of L4 from Schmorl's node or epiphysitis or both and spurring
57	W	L3–4	S	60	M	S	
53	W	L3–4	S	30	M-Adv.	S	Slight retroposition of L3 on 4, slight right convex scoliosis
56		L4–5	S	70	V. S.	S	Slight left convex scoliosis
58	W	L4–5	M	40	M	S	
55	W	L4–5	M	60	M	S	
59	W	L4–5	M	90	M	M	Slight right convex scoliosis
60	W	L4–5	M	15	V. S.	S	L5 transitional
56	W	L4–5	S	50	V. S.	S	L5 transitional
58	W	L4–5	S	70	M	S	Slight rotation between L4–5
56	W	L4–5	S	60	M	S	Air anteriorly, slight retroposition of L4 on 5
59	W	L4–5	S	70	M	S	Air to left
63	W	L4–5	S	85	S	S	Slight retroposition and left luxation, air anterocentrally
56	W	L4–5	S	30	S	S	Slight old compression fracture anterosuperior L5
55	W	L5–S1	S	40	N	S	Air posteriorly
62	W	L5–S1	S	30	M-Adv.	S	Air centrally
62	W	L5–S1	S	40	M	M	Air posteriorly
57	W	L5–S1	S	30	M	M	Air centrally
54	W	L5–S1	S	N	N	S	
55	W	L5–S1	M	90	S	M	
49	W	L5–S1	S	40	M	S	
52	W	L5–S1	S	25	V. S.	S	
64	W	L5–S1	M	60	S	S	
56	W	L5–S1	S	10	S	S	
59	W	L5–S1	M	60	S	C	
56	W	L5–S1	S	70	S	S	
58	W	L5–S1	M	70	S	N	
53	W	L5–S1	S	60	M	S	
53	W	L5–S1	M	90	S	S	
52	W	L5–S1	S	70	V. S.	N	Air posteriorly

* Code: N—none, V. S.—very slight, S—slight, M—moderate, M—Adv.—moderately advanced, C—considerable.

TABLE III—(*continued*)

SUMMARY OF ALL CASES OF GAS IN INTERVERTEBRAL DISCS

Age	Race	Disc	Amount of Air	Percentage Narrowing	Spurring	Eburnation	Miscellaneous Findings
67		L5–S1	M	40	M	M	
57	W	L5–S1	S	15	M	V. S.	
53		L5–6	S	50	M	M	L6 transitional
54	N	L5–6	S	60	S	S	Slight retroposition of L5 on L6, air centrally
61	W	T12–L1	S	N	S	S	Air anteriorly
		L5–S1	S	10	S	S	
55	W	L2–3	S	N	M	S	
		L4–5	S	10	V. S.	S	
55	N	L2–3	S	5	M	S	Air anteriorly
		L4–5	S	60	M	M	Air anterocentrally
62	W	L2–3	S	45	S	V. S.	
		L4–5	S	80	S	S	
60	W	L3–4	S	50	M	M	Air anterocentrally
		L4–5	S	50	M	M	Air anterocentrally
55	W	L3–4	M	90	M	M	Right side of L3–4 narrowed, air on right in AP view. Left side of L4–5 narrowed, air on left. Slight left convex scoliosis L3–4, right convex scoliosis L4–5
		L4–5	V. S.	90	C	C	
58	W	L3–4	M	95	M-Adv.	M	Narrowing on left, slight right convex scoliosis, air visible in AP view
		L5–S1	V. S.	30	M	S	
54	N	C5–6	V. S.	90	S	N	
		L4–5	S	5	V. S.	N	
		L5–S1	S	60	S	S	
53	W	T6–7	M	40	S	N	All changes on left
		L4–5	V. S.	N	N	N	
		L5–S1	S	15	N	S	
66	W	T12–L1	S	50	S	S	
		L1–2	S	50	S	M	
		L4–5	M	50	S	C	
		L5–S1	M	50	S	C	
57	W	T8–9	V. S.	N	S	N	
		T9–10	V. S.	N	S	N	
		T10–11	S	N	S	N	
		T11–12	M	20	M	M	Air visible in AP view.
		L1–2	M	50	M	M	Slight retroposition of L1 on L2

moderately advanced in 5, and considerable in 1. Only 2 of the gas-containing discs were not associated with either narrowing or spurring. Eburnation was another frequent finding in vertebral bodies next to discs containing gas, being present in all but 5 instances* (Table II). Eburnation was usually equal in the adjacent bodies (Fig. 4).

COMMENT

This study, which is based purely on roentgenologic findings in a series of 2,419 examinations of the lumbosacral spine, reveals that the vacuum phenomenon is much more common than previous reports would indicate. Until a study is undertaken which will correlate the occurrence of gas in discs with symptoms and physical findings, little will be known about the clinical significance of this roentgenologic finding. In the meantime, however, radiologists can train themselves to observe the presence of gas in discs, a fairly common finding which they may have been overlooking. Table III gives a complete summary of all positive cases.

SUMMARY

1. The so-called vacuum phenomenon, or gas, in intervertebral discs has been recognized only in recent years, and few cases have been reported.

2. A survey of 2,419 roentgen examinations of the lumbosacral spine showed the incidence of this condition to be 2.026 per cent.

3. Gas in discs is most frequent in the lower lumbosacral area. The lower two discs comprised 72.1 per cent of the 61 involved discs in this series.

4. The average age of patients found to have gas in discs was fifty-seven, and the youngest was forty-nine years.

5. Other changes frequently associated with gas in discs are narrowing of the spaces between the vertebral bodies, spurring of adjacent margins, and eburnation of adjacent bodies.

6. Further studies are needed to provide more information about gas in discs—a phenomenon which may be frequently overlooked.

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* In the cervical and thoracic areas, eburnation of the vertebral bodies adjacent to gas in discs was found in only one instance. This was in the eleventh and twelfth thoracic vertebrae, where moderate eburnation was noted.

TUMORS IN ONE OF HOMOLOGOUS TWINS

NEUROBLASTOMA; FIBROMYXOSARCOMA IN INFANT NEGRO TWINS*

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THE study of heredity in tumor formation in laboratory animals differs from clinical study in two most important points. The findings in laboratory animals do not always conform to those in humans. One can choose laboratory animals at will and keep them in cages for study. They can be purchased in great quantities. Human beings do their own choosing and they do not always go to institutions where they can be properly studied, or do not go for treatment at all. Hence our knowledge of heredity in tumor formation is mainly based on laboratory animals.

The best source for the study of human heredity in tumor formation is homologous twins. If the tendency to develop a certain type of tumor is transmitted by the parents to one of homologous twins, the other twin must of necessity have the same tumor if heredity plays a part in the tumor formation. However, tumors in homologous twins are not very common. Those that do come for treatment in different hospitals are not always reported; and in many instances the charts fail to reveal if the patient afflicted with a tumor has a twin brother or sister.

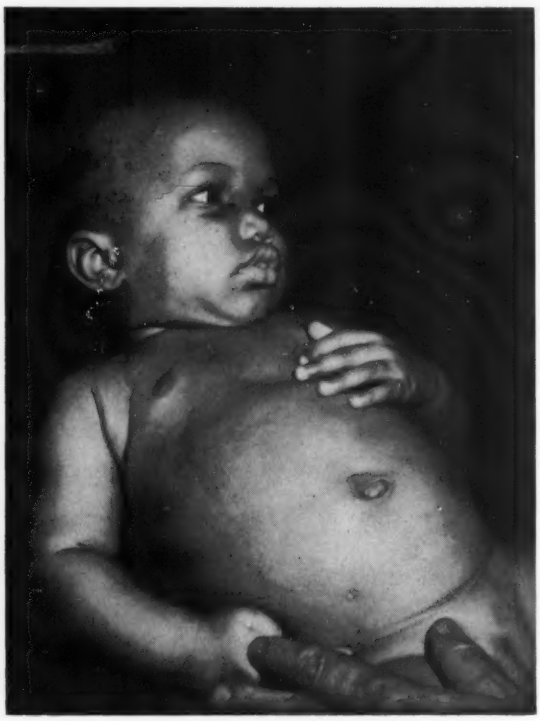

FIG. 1. Case 1. Shows recurrence of neuroblastoma at the inner canthus of right eye.

Tumors in one of homologous twins are even less often recorded in the literature than when both twins are similarly affected. This was brought out by Macklin[3] at the Seventh International Congress of Genetics in 1939. Furthermore, one cannot see enough cases in a lifetime to form any conclusions, especially if each pair of twins is to be observed for several years. Hence, it is worth while to add to those already reported 2 additional cases of tumors in one of homologous Negro twins, with the hope that they will be of some help in the study of the relationship of heredity to tumor formation. This makes six pairs of twins studied at the Brooklyn Cancer Institute in which only one of the twins was affected with a tumor.[1,2]

REPORT OF CASES

CASE 1. S. C., a six month old Negro female infant, was admitted to the Brooklyn Cancer Institute on June 17, 1946, from another hospital where a tumor had been removed from her right lower eyelid (Fig. 1). She was referred to our institution for roentgen therapy. The histopathological diagnosis of the tumor was neuroblastoma.

The infant was one of homologous twins (Fig. 2). She was born on December 10, 1945, three minutes following the birth of her sister. Both children were breech presentations (left sacro-

* From the John E. Jennings Hospital (formerly the Brooklyn Cancer Institute), Brooklyn, New York.

Fig. 2. Patient (Case 1) and homologous twin.

anterior). Ten minutes later the single placenta was expelled. At birth she weighed 7½ pounds; her twin sister weighed 7 pounds 12 ounces. Both were in good physical condition. Shortly after birth the mother noticed that the infant had a "bruise" at the inner side of the right eye (inner canthus). Two months later it had become larger; a month later it "started growing real fast," and she was brought to a hospital where the tumor was removed. She was then sent to us for roentgen therapy.

Her family history was essentially negative. Both parents were twenty years of age and in good physical condition. She had another sister a year and a half older. A third sister had died at birth. The mother noticed that both twins wet themselves at the same time and both had a bowel movement at 11 o'clock. Each one sucked her right thumb.

Examination revealed a six month old Negro female, well developed, with an indurated irregular scar and punched-out shallow ulceration in the center at the inner canthus of the right eye. The rest of the physical examination was essentially negative. Blood and urine examinations were within normal limits. The twin sister was in good physical condition.

A biopsy from the scar confirmed the diagnosis of neuroblastoma (Fig. 3). The patient received a course of roentgen therapy to the right infraorbital region and was discharged to the Out-Patient Department for further follow-up.

She was under our observation in the clinic and hospital from June 17, 1946, to January 11, 1948. During this time she developed exopthalmos of the right eye, metastases to the bridge of the nose, right ear, right cheek and submaxillary glands. Her condition became progressively worse and she died from pulmonary metastasis on January 11, 1948.

Her twin sister has been observed at three month intervals. She is well, with no evidence of malignancy in any part of the body. She was

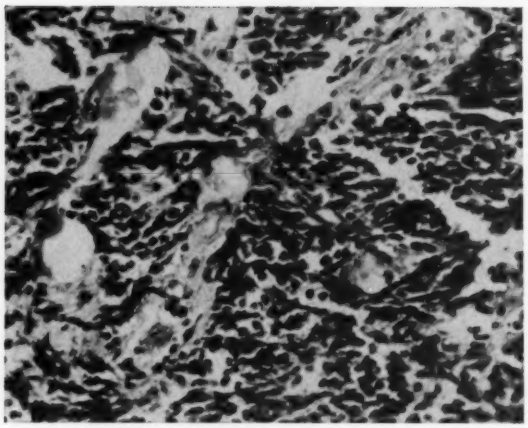

Fig. 3. Case I. Photomicrograph (×400) of neuroblastoma.

last seen May, 1953, approximately eight years after her mother noticed the tumor in her twin sister.

Case II. B.B., a two and one-half year old colored female, was admitted to the Brooklyn Cancer Institute on June 12, 1946, from another hospital, where a tumor had been removed from the abdominal wall in the left lower quadrant (Fig. 4). She was sent to us for radiation therapy.

The patient is one of homologous twins (Fig. 5). She was born on December 19, 1943, five minutes after her twin sister. Fifteen minutes later a single placenta was expelled. Both children were breech presentations (footlings) and were in good physical condition. The patient weighed 3 pounds, 7 ounces; her twin sister 3 pounds, 4 ounces. When fifteen months old, July 13, 1945, she was brought to Cumberland Hospital with a tumor in the left flank of eight months' duration. Examination at that time revealed a soft tissue mass the size of an orange

Fig. 4. Case II. Shows patient with scar in the left flank where tumor was removed.

Fig. 5. Patient (Case II) and homologous twin.

in the left lower quadrant of the abdominal wall, freely movable, with a tense overlying skin. The clinical impression was a "lipoma." In the operating room it was found that the tumor was soft and cystic, measuring 2 inches in diameter, and extending to the external oblique aponeurosis. The histopathologic diagnosis was fibromyxosarcoma (Fig. 6).

On May 9, 1946, she was readmitted with a recurrent tumor in the scar measuring 1 inch in diameter. The tumor was again excised and she was referred to the Brooklyn Cancer Institute for roentgen therapy. The second tumor was again diagnosed as fibromyxosarcoma.

At the Brooklyn Cancer Institute the patient received postoperative roentgen therapy to the scar. Roentgen examination of the skeleton and chest revealed no evidence of metastasis. The

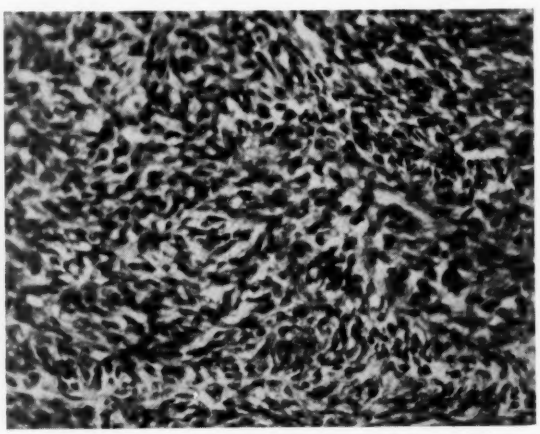

Fig. 6. Case II. Photomicrograph (×400) of fibromyxosarcoma.

laboratory findings were within normal limits, including the blood Wassermann reaction.

The patient and her twin sister have been examined at frequent intervals and found in good physical condition. The mother states that the two children are so indistinguishable from each other that the only way she can tell them apart is by a scar on the patient's cheek resulting from a burn. Both children have a habit of moving their shoulders up and down. Both get hungry and sleepy at the same time. The time of elimination is the same. Both had pneumonia at the same time. Both had rickets. Both play the same games and have the same temperament. Both have blood type O and are Rh positive.

They were last seen on November 11, 1952, eight and one-half years after the tumor was first noticed in one of the twins. There was no evidence of recurrence of the tumor or metastasis in the patient. Her twin sister was in good physical condition and showed no evidence of neoplasm in any part of the body.

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THE QUANTITATIVE ESTIMATION OF RADIOACTIVE ISOTOPES BY RADIOAUTOGRAPHY

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INTRODUCTION

THE technique of radioautography which utilizes a photographic emulsion to localize the histological sites of radioactive isotopes in tissues may be extended to measure relative concentrations of isotopes in microscopic sites. Such quantitative radioautography can be applied as a histophysical method to many problems of biological interest. This is being done in thyroid studies to be reported elsewhere. The present work is a critical discussion of the available techniques for quantitative radioautography.

The theory and methods of radioautography have been completely reviewed recently.[1,3] Photographic density and resolving power are two general properties of every radioautograph. The former consideration is important in the quantitative approach, whereas the latter is the significant feature where the aim is histological localization. The essential problem in quantitative radioautography consists of determining the relationship between the tissue concentration of radioactive isotope and the intensity of the resultant photographic reaction (density). The purpose of this paper is to present the theoretical and practical aspects of this subject, and, to illustrate the technique adopted.

The investigation of this problem is divided into three main parts, for each of which an analysis will be given. First, a suitable method for measuring the density has to be selected. Second, it is then necessary to deduce from this measurement the actual quantity of incident radiation (exposure) at the site of the radioautographic image. Third, the exposure must be related to the tissue concentration of radioactivity. This can be obtained theoretically by mathematical considerations involving the geometry of the reactive structures in the histological sections and their relation to the photographic emulsion. When the microscopic source of radioactivity is of sufficiently small size, this problem is much simplified. Finally, the theoretical results have been experimentally corrected to provide a functional relationship between the photographic density and the tissue concentration of radioactive isotope.

THEORY AND METHODS

Measurement of Photographic Density. The radioautographic image is represented by the accumulation of microscopic black grains in the photographic emulsion. For the purposes of quantitative radioautography, there are three possible methods to measure the intensity of the image photographic blackening; namely, nuclear track studies in highly sensitive emulsions, densitometry, and grain counting.

The first method is, at present, not entirely feasible for routine work with beta-ray emitting isotopes.

The second method, densitometry, is suited for relatively greater optical densities; hence, the densitometer is best operated with the radioautographic image projected at relatively low magnifications. Odeblad[5] has successfully applied this technique with reference to P^{32} in graafian follicles. Briefly, the enlarged image is focussed by a photomicrographic apparatus at the level of the search unit (photoelectric receptor) of the densitometer. Then, the intensity of incident light (I) and transmitted light (T) is read, and the density (D) determined according to the formula: $D = \log I/T$. It is understood that the density so recorded represents the image black-

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ening through the depth of focus in the photographic emulsion. For satisfactory results with the ordinary photoelectric densitometer, it is necessary to use optical density values which are relatively greater than what is considered suitable for good radioautography of microscopic objects. Reference to previous theoretical considerations[1,3] will indicate that, as the exposure is increased to raise the radioautographic density, the resolving power is automatically decreased. Furthermore, as will be shown later, the direct relationship between density and exposure existing at low densities may no longer be valid with the relatively high densities used in densitometry. Another distinct disadvantage of this method is that variations in opacity of the underlying tissue medium will affect the intensity of the incident light (I), which is really only estimated by taking an intensity reading over a nonradioactive tissue area where, however, the opacity may be different. (For this reason, contact radioautography would accordingly be the best choice, since the radioautograph can be separated from the tissue and the density of the image determined independently.) Consideration given to the possible error obtainable with densitometry (Appendix 1) will indicate that with ordinary densitometers working under ideal conditions of high values for incident intensity and a stable instrumental set-up with constant illumination, the accuracy that can be expected is no better than with grain-counting. It is emphasized, however, that densitometry carried out with especially perfected instruments designed for this use would not necessarily involve all these objections.

Experience has indicated that, for several reasons, the densitometric technique is not as favorable as the grain-counting method which has been developed to produce practical results with regard to radioiodine localization in the colloid of thyroid follicles. Other workers[7] have also employed a grain-counting approach for radiophosphorus estimations in nuclei. The differences in the procedures depend on the size of the tissue source of radioactivity. The reason is that with a small source, such as a squashed cell nucleus, it is possible to count all the grains affected by the radiation, and then accept this figure as a measure of the radioactive content of the nucleus from which the radioactivity concentration can be determined knowing the nuclear volume. With relatively larger sources, such as histological sections of thyroid follicles, the task would be far too tedious, and so only those grains confined to a certain area in the center of the colloid are taken into account. A comparable approach could be adopted for other geometrical sources such as the layers of radioactivity that are observed with radiophosphorus localized in bone. With these limitations, however, it then becomes necessary to determine the relationship between the density at the restricted site in which the grains are counted and the true tissue source concentration of radioactivity (see later).

Before describing the details of grain-counting used in thyroid research, it should be noted that the two methods of densitometry and grain-counting are essentially equivalent. It has been demonstrated[2] that the photographic density, as measured by the densitometer, in a certain volume is practically directly proportional to the mass of silver deposited in the form of grains in that volume. Accordingly, assuming that there is a constant mass of silver per developed grain, the density is proportional to the number of grains involved. In fact, with grain-counting, the density will ultimately be deduced from the counts to compare relative tissue contents of radioactivity.

It is important that all extraneous factors influencing the formation of the autographic image be properly controlled. Obviously, comparisons can only be made with images formed in the same emulsion by the same radioisotope. In practice, satisfactory results have been obtained with either the coating or stripping film techniques. Contrary to the densitometric

method, adequate staining procedures may be used as desired. It is necessary to guarantee uniformity of the tissue section thickness, tissue-emulsion interspace, and developing procedures. The emulsion thickness requirements, however, vary according to the type of density-measuring procedure employed. For densitometric methods and cases where all the grains in the depth of the emulsion are to be counted, it is essential that a uniform emulsion thickness be procured. In the technique to be described this condition is unnecessary. However, emulsion thickness, besides increasing the photographic density, adversely influences resolving power.[1] Another consideration is that a thicker emulsion, which thus provides a greater number of developable grains, reduces statistical variations and, hence, the probable error of density measurement.

The emulsion characteristics and development method employed for grain-counting should be such that the grains tend to be small, regular, discrete (non-clumped), concentrated and sensitive. Nuclear emulsions are most satisfactory, the melted Ilford Half Tone type having been used in the coating method of this laboratory. The exposure time should be limited to densities in which the grain number can easily be read, the exact values being determined by trial. Contrary to the case with densitometry, however, these minimal exposure-time requirements are ideally suited for optimal radioautography.

The grain-counting method developed for thyroid radioautographs consists essentially of totalling the number of grains existing at distinct levels in the photographic emulsion over the center of the colloid. Using oil immersion, the objective is focussed at the colloid emulsion interspace when the grains at first come into sight. The visible number of grains contained within a 75 sq. micron area (formed by a grid placed in the ocular) is counted and recorded. The focus is then raised successively through 2 micron levels and the grain number is counted each time, through a total 10 micron depth of the emulsion. The objective is always moved in only one direction to avoid mechanical backlash. Then, the total number of grains in the six levels are summed and recorded as the density measurement. It should be pointed out that, in practice, depending on the statistical variability, it may not be necessary to count as many as six levels, one or two being sufficient. It has been found that, with the coating technique, for a single count, the 2 micron level is the most reliable as an index of density. (As will be indicated later, however, six levels were used in order to test the validity of an inverse square law assumption for radiation intensity.) The advantages of counting grains in separate levels are twofold: first, it facilitates time and effort; second, it renders it unnecessary to control the emulsion thickness. It is necessary, finally, to make comparable readings for fog and subtract the average from the mean density values. By thus performing density measurements over each colloid in the tissue section, and making suitable corrections for colloid section diameter (see later), relative radioiodine concentrations were interpreted for thyroid follicles of all diameters.

A serious objection to grain-counting is the tediousness of the method. In practice, after two or three hours, the efficiency of the operator begins to diminish. It has been estimated, however, by experience, that, with reasonable care, the possible error due to personal reading inaccuracies does not exceed ± 10 per cent. (Recent technical achievements indicate that, in the future, it may be possible to incorporate an automatic grain-counting device in the microscope, thus facilitating density measurement.)

The Relation Between Photographic Density and Radiation Exposure. In a previous paper,[1] it was illustrated that the density-exposure relationship is very nearly:

$$D = D_m(1 - e^{-KQ})$$

$$= D_m\left(KQ - \frac{(KQ)^2}{/2} + \frac{(KQ)^3}{/3} - \cdots\right),$$

where

D is the photographic density,
D_m is the maximum density possible for the emulsion,
$\mathcal{Q}$ is the amount of radiation exposure, which is the integrated product of radiation intensity (I) and time duration of photographic exposure (T),
K is the unknown constant, dependent on the emulsion and radiation characteristics.

For small values of $\mathcal{Q}$, this relation reduces to $D = D_m K \mathcal{Q}$.

Since it was shown earlier in the paper that the photographic density is proportional to the number of grains developed, it follows that:

$$N = N_m K \mathcal{Q}, \qquad (1)$$

where

N is the number of image grains produced in a given volume,
N_m is the maximum number of developable grains in that volume.

Accordingly, this convenient linear relationship permits interpreting the grain count as a direct measure of radiation expsosure.

It is interesting to note that according to the specifications of the Ilford nuclear emulsion and the properties of the microscope used (Leitz, N.A. = 1.25, obj. 1.8 mm.), the maximum number of grains included in the depth of focus of the counting area was 200. In practice, the number of grains counted never exceeded 50 and usually was less than 30. The deviation between the exponential and linear formulae for $K\mathcal{Q}$ when $N_m = 200$ and $N = 40$ is 9 per cent. Hence, the error in the simplified direct formula employed for readings at these low densities is theoretically less than 9 per cent. This statement was experimentally substantiated in that, for low optical densities, the deviation of the predicted grain count from the measured was less than 10 per cent.

The Relation Between Radiation Exposure and Tissue Radioactivity Concentration. In a previous paper[3] it was shown how, by assuming an inverse square law relationship for β-radiation, the influence of the geometrical relations of the source and emulsion on the radioautograph could be theoretically determined. Thus, it was possible to estimate the relative effects of solid circular cylindrical sources of radioactivity which are approximately the shapes assumed by the sectioned colloids of thyroid follicles. The only modification of that first analysis, which is now necessary, is to omit the initial integration over the entire depth of the emulsion, and instead, carry through the mathematical calculations precisely as before for various separate emulsion levels. Finally, the mean relative theoretical radiation intensity per 75 square micron area at emulsion levels 0, 2, 4, 6, 8, 10 microns over the center of the colloid can be determined. Figures 1 and 2 illustrate such theoretical intensities as well as their

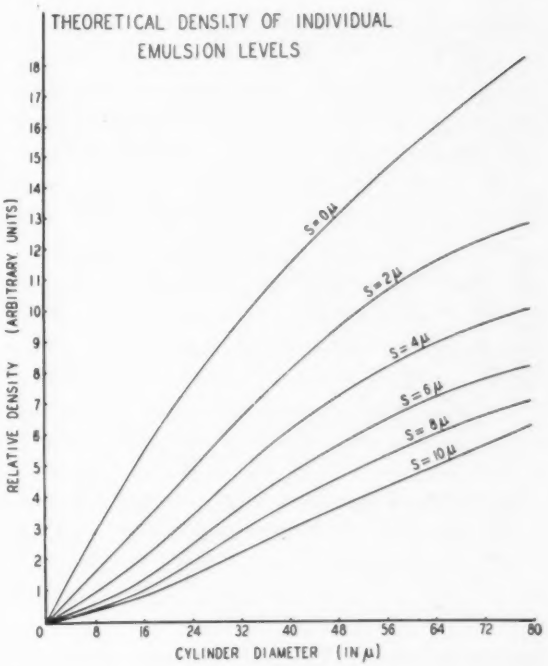

FIG. 1. Graph showing the influence of the diameter of a solid circular cylindrical source on the theoretical relative photographic density in the radioautographic image. It is assumed that the radioactivity concentration is homogeneous and constant. The density determination is made over the center of the cylinder at individual emulsion levels (s microns) above the tissue-emulsion interspace.

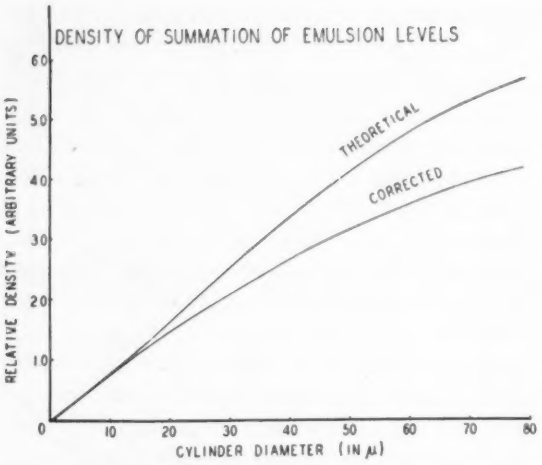

FIG. 2. Graph showing the influence of the diameter on the sum of the theoretical densities determined at $s=0$, 2, 4, 6, 8 and 10 microns in Figure 1. The corrected plot is the result of interpretation of experimental results (see Appendix II).

summation, for cylinders of diameter 0 to 80 microns with uniform hypothetical concentrations of radioactivity.

Experimental evidence to be presented indicates, however, that the law governing the β-radiation intensity for radioautographs does not strictly follow an inverse square formula. Results obtained only at an air pressure of 1.0 mm. Hg favor the validity of an inverse square law.[5] Factors to be considered which modify the basic assumption and which serve to explain the experimental results are: scattering of β-rays; and, the diminution of kinetic energy rendering the space rate of energy loss greater, so that the photographic effect increases along the path of the particle. Furthermore, the theoretical calculations were based on a tissue section of 7 microns and a tissue-emulsion interspace of 0.1 micron. These figures were estimated from profile sections made of radioautographs.[1] Any increase in either of these two figures would tend to make the experimental values more compatible with the theoretical.

Experimental grain counts were obtained from radioautographs of thyroid sections taken from animals previously injected with I^{131}. From these values, by complex mathematical manipulations, suitable corrections for the theoretical curve (Fig. 2) were obtained. (The results and mathematical details are contained in Appendix II.) This corrected function thus completes this section of the problem of quantitative radioautography, since the photographic density at the radioautographic image (which is proportional to the intensity of radiation) can then be corrected for colloid diameter, assuming that the sectioned colloid is a solid circular cylinder. The final result will compare the relative colloid concentrations of I^{131} for diameters of various sizes. Interesting biological results, for example, have been obtained with respect to the relative changes in concentration which occur at various time intervals after injection, yielding comparisons for the rate of turnover of I^{131} according to follicle size.[4]

It is suggested that a similar mathematical approach be made in other cases where the geometry of the source complies with the configuration of a plane, cube or cylinder. It is emphasized that such an approach is necessary where *not all* the grains developed by the tissue source of radioactivity are counted due to the relatively large size of the microscopic source. In these cases where the size may vary, it is essential to know the relation between

TABLE I

RATIO OF EXPERIMENTAL TO THEORETICAL GRAIN COUNTS FOR VARIOUS COLLOID DIAMETERS AND EMULSION LEVELS

(Ratio Arbitrarily Unity at Emulsion Level 2 Microns)

Mean Colloid Diameter in Microns	Emulsion Levels above Tissue-Emulsion Interspace in Microns					
	0	2	4	6	8	10
13	0.88	1.0	1.2	1.8	2.1	1.8
17	0.89	1.0	1.2	1.6	2.0	2.0
23	0.91	1.0	1.2	1.5	1.8	2.0
28	0.98	1.0	1.2	1.4	1.7	2.0
33	1.0	1.0	1.1	1.3	1.5	1.8
38	1.1	1.0	1.1	1.4	1.7	1.8
45	1.3	1.0	1.1	1.3	1.6	1.8
60	1.3	1.0	1.2	1.4	1.7	1.9
80	1.2	1.0	1.0	1.1	1.3	1.4

TABLE II

RATIO OF SUM TO INDIVIDUAL GRAIN COUNTS IN SEPARATE EMULSION LEVELS FOR COLLOIDS OF VARIOUS DIAMETERS

Mean Colloid Diameter in Microns	Emulsion Levels above Tissue-Emulsion Interspace in Microns					
	0	2	4	6	8	10
13	3.2	4.9	6.7	7.5	8.7	11.8
17	3.3	5.1	6.6	7.8	8.1	9.8
23	3.6	5.2	6.3	7.3	8.1	9.3
28	3.7	5.5	6.3	7.1	7.8	8.7
33	3.7	5.5	6.3	7.0	8.0	8.8
45	3.2	6.0	7.0	7.5	7.9	8.7
60	3.6	6.0	6.5	7.2	7.1	8.2
80	3.4	5.6	7.0	7.8	7.7	8.2

the intensity of radiation at the site where the radioautographic image density is determined and the concentration of radioactivity in the particular geometrical source under consideration.

The complexity of the problem is considerably reduced where the histological source of radioactivity is small, as in cells or nuclei. Here, the total number of developed grains over the source can be counted, and related directly to the relative radioactivity content of the source, whence the relative concentration may be determined by estimating the volume.

Mathematical Interpretation. The discussion regarding the theoretical basis for these methods can be conveniently summarized in mathematical form. Adopting the notation on page 817, Equation (1) relates the grain count with the intensity of radiation:

$$N = N_m K \int_0^T I dt \qquad (2)$$

which is true for short exposures.

The intensity of radiation, I, at the photographic image, where the grains are counted, is itself a function of two independent variables: the concentration of radioactivity in the source and the geometrical factors of the radioautograph. If the concentration at time, t, be expressed as C_t, the radiation intensity is proportional to the rate of disintegration of the radioactive isotope, $-dC_t/dt$, *i.e.*, the rate of ejection of β-particles. The nature of the second function, f, can be theoretically calculated according to the scheme outlined in a previous article.[3] An example of this, with an indication of the corrective factors, is described in Figure 2 and Appendix II. In this particular case, the function, f, is dependent on the diameter of the thyroid section as well as the tissue section thickness and the tissue-emulsion interspace. In those instances where all the developed grains in the radioautograph are counted, the function, f, is proportional to the volume of the microscopic source provided the source is of uniform thickness and the concentration of radioactivity is uniform. Accordingly,

$$I = -\frac{dC_t}{dt} f. \qquad (3)$$

By the fundamental law of radioactivity,

$$\frac{dC_t}{dt} = -\lambda C_t \qquad (4)$$

where λ is the disintegration constant of the radioactive isotope. Combining Equations (2), (3), (4), and mathematically integrating:

$$N = N_m K (1 - e^{-\lambda t}) C_0 f. \qquad (5)$$

That is, for the given radioactive isotope and photographic procedure (in which N_m, K, and T are constant), the number of grains developed, N is proportional to the product of the initial concentration of radio activity in the source, C_0, and of the function described as f. Hence, relative values may be determined for the tissue concentration of radioactivity for changes in the values of N and f.

The two inherent factors of any isotope which affect the ratio N/N_m (Equation 5) are λ and K. In this respect, it is interesting to compare, for example, the radioautographic effect produced by an equal concentration of atoms of C^{14} and I^{131}. The disintegration constant for C^{14} (0.031×10^{-5} da^{-1}) is very much less than for I^{131} (0.087

da^{-1}). Accordingly, this greatly reduces the photographic density for the C^{14} radioautographs for equal exposure times. On the other hand, since the mean energy of β-particles emanating from C^{14} (0.05 mev.) is less than from I^{131} (0.2 mev.), the average mean space rate of energy loss of C^{14} β-particles is, therefore, greater.[1,3] Hence, this factor increases the mean photographic density per unit volume of emulsion for C^{14} radioautographs. The net effect in this particular case, however, is more greatly influenced by the disintegration constant factor.

SUMMARY

The theory and methods of quantitative radioautography have been reviewed. The technique favored for most biological applications is that of grain-counting. The two varieties of this method which are being used are either counting all the developed grains of the radioautograph produced by a given structure, or taking into account only those grains of specific layers in a given area over the center of the source. The latter method is practical where the histological reactive structures are relatively microscopically large, such as in the case of thyroid follicles. The required formulae for the interpretation of density measurements have been theoretically established. The basic assumptions were experimentally tested, providing correction factors which finally yielded a relationship between the photographic density of the radioautographic image and the tissue concentration of radioiodine.

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APPENDIX I

Possible Error in Densitometry. The possible error in D due to reading inaccuracy of $I(\pm\Delta I)$ and $T(\pm\Delta T)$ can be estimated by mathematical differentiation of $D=\log I/T$. Whence, the per cent possible error is:

$$\frac{\Delta D}{D}\times 100=\frac{(I+T)}{IT\log_e\dfrac{I}{T}}\delta\times 100,$$

where δ is the positive value of ΔI or ΔT in densitometer scale units. Analysis of this formula reveals that the possible error increases as either the intensity of incident light or the density decreases.

APPENDIX II

The Correction of the Theoretical Predictions for the Relation Between Radiation Intensity and Thyroid Colloid Diameter. The theoretical predictions for the photographic density due to thyroid colloid sections were based on an inverse square law assumption for radiation intensity.[3] Values for photographic density were determined for separate emulsion levels, s, and for various colloid diameters, d (Fig. 1 and 2), assuming a uniform concentration of radioactivity in a circular cylindrical source.

In an experiment designed to test the validity of these relations, thyroid radioautographs were prepared from groups of homogeneous laboratory male rats previously injected with I^{131}. The photographic densities of the radioautographs were estimated by the grain-counting method as described in the text. All the values for separate colloid section diameter ranges 10–15 microns, 15–20 microns, etc., were aggregated and averaged (200–400 follicles sections per range).

It is clear that it is not of any use to compare the ratios of experimental and theoretical counts for changes in d, since it is likely that the concentration of radioactivity is different for colloids of various diameters. If, however, the theoretical predictions were correct, experimental-theoretical ratios would be constant for all values of s, for a given diameter range.

In each diameter set, the experimental count for the emulsion level 2 microns above the tissue-emulsion interspace ($s=2$) was arbitrarily put at 10 units and the count at the remaining emulsion levels were proportioned on this basis. Similarly, the theoretical counts for a given diameter range were all multiplied by an arbitrary factor so that the values at $s=2$ were all equal to 10 units. Let the so modified theoretical and experimental counts be repre-

sented by $C(s, d)$ and $C'(s, d)$, respectively. Since, according to the arbitrarily set scale, $C'/C = 1$, for $s = 2$, then, if the theory were valid, C'/C would be equal to unity for all s. Table 1 demonstrates that, in fact, there is a deviation from the theoretical results, requiring a corrective factor. It can be deduced that the rate of decline of the experimental counts with respect to emulsion level is less than predicted, for which possible physical explanations have been stated in the text.

Let the required corrective factor of $C(s, d)$ be designated by $p(s, d)$. Then, the ratio $q = C'/pC$ is constant for all s for any given diameter. Thus q is an unknown function of d only.

Since

$$C' = qpC \tag{I}$$

then,

$$\sum_s C' = q \sum_s pC \tag{II}$$

where the summation is taken over $s = 0, 2, 4, 6, 8, 10$ microns according to the method described.

Suppose there is a value of $s = \rho$ for which

$$\sum_s pC = ap(\rho, d)C(\rho, d) \tag{III}$$

where a is a constant for all d. That is, the corrected theoretical summation curve is proportional to the corrected individual level curve at $s = \rho$, for all d. Hence, from Equations (I) and (II),

$$C'(\rho, d) = q(d)p(\rho, d)C(\rho, d)$$

$$\sum_s C'(s, d) = q(d)ap(\rho, d)C(\rho, d).$$

Dividing, we obtain:

$$\frac{\sum_s C'(s, d)}{C'(\rho, d)} = a, \text{ constant for all } d.$$

Inspection of Table II indicates that the experimental values demonstrate that this condition is very nearly fulfilled, for all $\rho = 0, 2, 4, 6$, and 8 microns.

Hence, from Equation (III), it follows that $\sum_s pC$ is proportional to C, for any $s \leq 8$ provided p is constant. That is, the corrected summation is directly proportional to the theoretically predicted count for an individual level, say $s = \sigma$, provided the corrective factor $p(\sigma, d)$ is constant for all d. Hence, for $s = \sigma$ the ratio of theoretical values for any two diameters would be valid for the ratio of the corrected summed values. To find σ suppose:

$$\frac{\partial}{\partial d}\left(\frac{C'}{q}\right) = \lambda' \frac{\partial}{\partial s}\left(\frac{C'}{q}\right) \tag{IV}$$

and

$$\frac{\partial}{\partial d}(C) = \lambda \frac{\partial}{\partial s}(C) \tag{V}$$

where it is obvious neither λ' nor λ are zero for finite values of s and d. Then from Equations (IV) and (V),

$$\frac{\dfrac{\partial}{\partial d}\left(\dfrac{C'}{q}\right)}{\dfrac{C'}{q}} = \frac{\lambda' \dfrac{\partial}{\partial s}\left(\dfrac{C'}{q}\right)}{\dfrac{C'}{q}}$$

and

$$\frac{\dfrac{\partial}{\partial d}(C)}{C} = \frac{\lambda \dfrac{\partial}{\partial s}(C)}{C}$$

whence,

$$\frac{\partial}{\partial d}\left(\log_e \frac{C'}{q}\right) = \lambda' \frac{\partial}{\partial s}\left(\log_e \frac{C'}{q}\right)$$

$$\frac{\partial}{\partial d}(\log_e C) = \lambda \frac{\partial}{\partial s}(\log_e C)$$

and, subtracting and rearranging:

$$\frac{\partial}{\partial d}\left(\log_e \frac{C'}{q} - \log_e C\right) = \left(\lambda' \frac{\partial}{\partial s} \log_e \frac{C'}{q} - \lambda' \frac{\partial}{\partial s} \log_e C\right) + \left(\lambda' \frac{\partial}{\partial s} \log_e C - \lambda \frac{\partial}{\partial s} \log_e C\right),$$

i.e.,

$$\frac{\partial}{\partial d} \log_e \frac{C'}{Cq} = \lambda' \frac{\partial}{\partial s} \log_e \frac{C'}{Cq} + (\lambda' - \lambda) \frac{\partial}{\partial s} \log_e C,$$

i.e.,

$$\frac{\partial}{\partial d} \frac{C'}{Cq} = \lambda' \frac{\partial}{\partial s} \frac{C'}{Cq} + \frac{(\lambda' - \lambda)C'}{C^2 q} \frac{\partial}{\partial s} C;$$

but, since

$$\frac{C'}{Cq}=p$$

$$\therefore \quad \frac{\partial}{\partial d}p=\lambda'\frac{\partial}{\partial s}p+\frac{(\lambda'-\lambda)p}{C}\frac{\partial}{\partial s}C.$$

At

$$s=\sigma, \qquad \frac{\partial}{\partial d}p=0,$$

$$\therefore \quad \lambda'\frac{\partial}{\partial s}p+\frac{(\lambda'-\lambda)p}{C}\frac{\partial}{\partial s}C=0. \quad \text{(VI)}$$

The conditions of Equation (VI) are satisfied by

$$\frac{\partial}{\partial s}p=0 \quad \text{and} \quad \lambda'=\lambda$$

since

$$\lambda', p, \frac{\partial C}{\partial s},$$

are not each equal to zero.
It can be shown however, that if $\lambda'=\lambda$, then

$$\frac{\partial p}{\partial s}=0,$$

so that the two conditions are actually identical. From Equation (IV).

$$\frac{\partial}{\partial d}\left(\frac{C'}{q}\right)=\lambda'\frac{\partial}{\partial s}\left(\frac{C'}{q}\right)$$

but

$$\frac{C'}{q}=pC$$

$$\therefore \quad \frac{\partial}{\partial d}(pC)=\lambda'\frac{\partial}{\partial s}(pC)$$

or

$$p(\sigma)\frac{\partial}{\partial d}C=\lambda' p(\sigma)\frac{\partial}{\partial s}C+\lambda' C(\sigma)\frac{\partial}{\partial s}p,$$

since

$$\frac{\partial p(\sigma)}{\partial d}=0,$$

but

$$\frac{\partial}{\partial d}C=\lambda\frac{\partial}{\partial s}C \qquad \text{(V)}$$

therefore, from Equations (V) and (VII),

$$\lambda p(\sigma)\frac{\partial}{\partial s}C=\lambda' p(\sigma)\frac{\partial}{\partial s}C+\lambda' C(\sigma)\frac{\partial}{\partial s}p. \quad \text{(VIII)}$$

Hence, if $\lambda=\lambda'$ then

$$\lambda' C(\sigma)\frac{\partial}{\partial s}p=0,$$

or

$$\frac{\partial}{\partial s}p=0, \quad \text{at} \quad s=\sigma.$$

But,

$$\frac{\partial}{\partial s}p=\frac{\partial}{\partial s}\left(\frac{C'}{Cq}\right)=\frac{1}{q}\frac{\partial}{\partial s}\left(\frac{C'}{C}\right),$$

since

$$\frac{\partial}{\partial s}\left(\frac{1}{q}\right)=0.$$

Hence the necessary condition at $s=\sigma$ for

$$\frac{\partial}{\partial s}p=0$$

is

$$\frac{\partial}{\partial s}\left(\frac{C'}{C}\right)=0.$$

From the values of C'/C in Table I, plots were drawn with the purpose of finding minima at $s=\sigma$. The appropriate value for σ was found to vary between $0\leq s\leq 3$ according to the diameter. Actually, the results for $d\leq 23$ are more nearly accurately expressed by $s<0$. Recalling that $\sum_s pC$ is proportional to $C(\sigma)$ the rate of increase of $\sum_s pC$ was obtained according to that of $C(\sigma)$ for the given set of diameters. The value of $\sum_s pC$ was arbitrarily set equivalent to that of $\sum_s C$ at the minimum recorded diameter, 13 microns. The results are finally plotted in Figure 1.

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A NEW METHOD OF STEREOSCOPIC ROENTGENOGRAPHY

"TWIST STEREO" METHOD

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THIS is a description of a new method for taking stereoscopic roentgenograms which, like the conventional method, requires two exposures but eliminates the need for shifting the tube. The stereoscopic effect is produced either by a slight rotation or inclination of the part being examined, alone, or along with the entire body. This method has become known as the "twist stereo" method to the technicians who use it. The rotation produces stereoscopic roentgenograms like those taken by the conventional cross shift, while the use of the tilt gives the up and down shift effect. Since the tube distance is not a factor in this method, the amount of rotation or inclination remains constant. The best results are obtained if a rotation or inclination of 5 to 7 degrees is used, but there is a tolerance somewhat above 7 degrees.

The elimination of the tube shift offers a number of advantages. These advantages are: (1) The elimination of the possibility of tube cut-off as a result of a shift of the tube, making possible the use of a smaller cone. The use of a smaller cone increases the sharpness of the roentgenogram. (2) In the conventional method, a cross shift of the tube introduces the possibility of grid cut-off, while in this method, this difficulty is eliminated. (3) The interval between exposures is greatly shortened. (4) In teleroentgenography, the tube distance necessitates the use of an up and down shift, for the distance the tube must be moved to achieve the stereoscopic effect makes it impractical to use the cross shift. As a result of the up and down shift, the roentgenograms cannot be viewed in a vertical position. In this method, the same rotation as is used in shorter tube distance is employed, and the resulting stereoscopic roentgenograms, being equivalent to a cross shift, can be viewed in the vertical position. (5) The method can also be used in making stereoscopic spot roentgenograms in myelography.

General Procedure. The procedure is as follows: The tube is centered identically as in nonstereoscopic roentgenography. A film is placed in position in the Bucky and an exposure is made. A second film is placed in the Bucky. The tube is not shifted for the second exposure. Instead, the part being roentgenographed is either rotated about 5 degrees on the long axis of the table or inclined sagittally 5 degrees. The second exposure is now made and the stereoscopic set is completed.

Where the rotation or inclination affects the shape of the part or its relationship to the rest of the body (as in fluid levels or joints), the method is not applicable, except in instances where the distortion or displacement of the parts can be eliminated by changing the position of the patient from horizontal to vertical, or vice versa. As an example, in the case of pleural effusions, the level is not changed with the patient in the erect position.

This method has proved particularly advantageous in stereoscopic roentgenography of the skull. For example, during the last year because of clarity of detail made possible by the "twist stereo," for the first time we were able to visualize pineal calcifications in the posteroanterior or anteroposterior view in over 90 per cent of 200 consecutive cases of individuals over twenty years old who showed a calcified pineal body in the lateral projection.

The manipulation and proper rotation or

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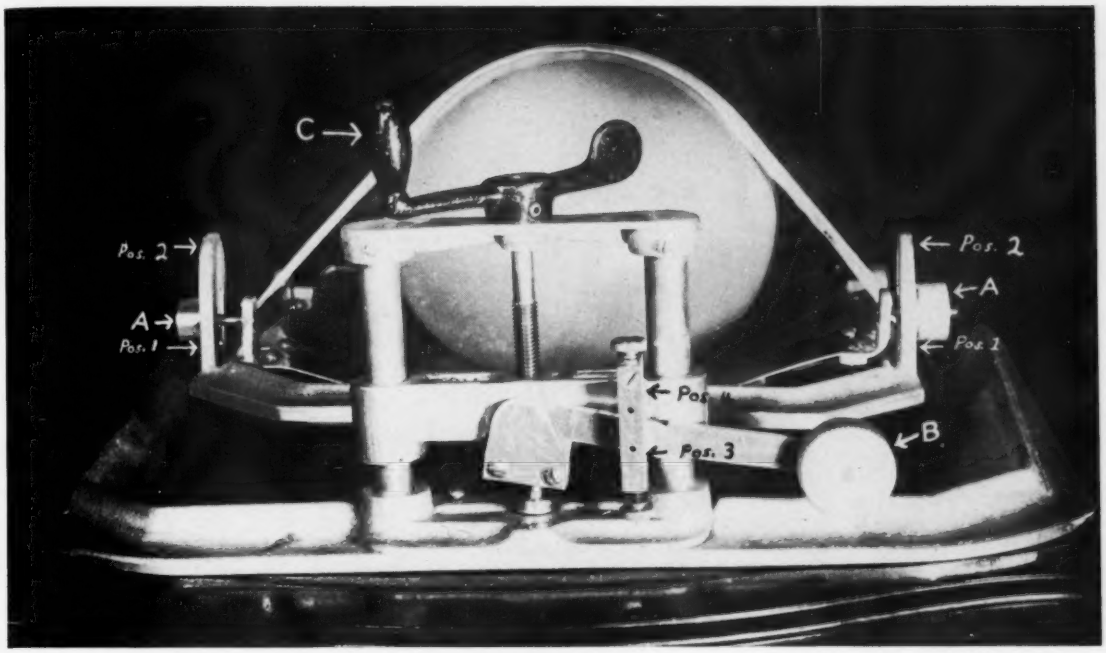

Fig. 1

inclination of the skull requires initial care and practice. After it is mastered, it is a simple procedure. To make the method more automatic and to make it possible to hold the head still, a new head clamp was designed, although the head clamps now in use may also be employed for this method.

The Apparatus and Its Use. The apparatus (Fig. 1) consists of a base, a shelf, a restraining band, and the controls necessary to obtain the rotation or inclination needed to achieve the stereoscopic effect.

The apparatus is placed on the table and the patient's head is placed in the desired position. The restraining band is tightened with only enough pressure to prevent the patient from changing his position. A film is placed in the Bucky in the proper relation to the skull. The tube is centered to the film, using the smallest cone which will cover the area of the film.

To obtain a cross shift effect, the procedure is as follows: When the patient has been positioned, the restraining band tightened, and the film and tube are in position, the first exposure is made. The second film is placed in position in the Bucky, and the lever marked "*B*" is the lifted from position 3 to position 4. This movement of the lever has rotated the platform on which the head is held counterclockwise. The second exposure is made, completing the set of stereoscopic roentgenograms.

To obtain the up and down shift effect, the same procedure is followed as above in taking the first film of the stereoscopic pair. The second film is placed in position in the Bucky, and the two knobs marked "*A*" (which operate simultaneously) are moved from position 1 to position 2. The result of this movement is to incline the platform together with the head. The second exposure is made, completing the stereoscopic set.

The apparatus is also effective in obtaining the proper positioning of extremely stout patients. The handle marked "*C*" controls the height of the platform from the table. A stout patient placed in position for a lateral view of the skull will have the vertex of the skull closer to the table than

the chin; the result is the patient is not in a true lateral position. By turning the handle marked "*C*," the platform is raised a few inches above the table. This results in the elevation of the vertex of the skull and a true lateral position. If it is desired to compensate for the enlargement of the skull which is a result of the increased film to object distance, the tube distance is increased.

In doing away with the tube shift, the use of a much smaller cone is possible and consequently the quality of the roentgenograms is improved. Since the tube is in a fixed position, and with the accuracy of positioning achieved with the head clamp devised, it is possible to eliminate the waste in film by reducing the amount of unused film to a minimum. We have found that an 8 by 10 inch film is usually large enough for stereoscopic roentgenograms of the skull, only the tip of the chin is not included. The time needed to do a stereoscopic examination has been shortened. The problem of the direction of the grids is no longer a factor. The amount of rotation or inclination being constant for all tube distances, equally as good results are obtained at 60 or 72 inch tube distances as at the more usual 30 or 36 inch tube distances.

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EFFICIENCY OF RED GOGGLES

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WE HAVE uncritically accepted red goggles to adapt our eyes for roentgenoscopy ever since their introduction for military purposes about 1942.[1] The study reported here indicates that, while useful, they do not rate the efficiency usually accredited them.

Red filters are undoubtedly superior to neutral ones in securing dark adaptation, although the difference is not great at certain light levels.[5] Chamberlain[2] stated the attitudes existing in 1942: "By the use of appropriate filters and light source, the clinical fluoroscopist could dark-adapt his eyes without going through the ordeal of complete idleness that has plagued him these many years; if especially radiolucent parts are under scrutiny, so that brightness levels sufficiently high for cone vision are obtainable (above 0.013 to 0.014 millilambert) . . . a wait of three to five minutes would be ample . . .; for all thicker parts (brightness levels too low for cone vision) adaptation would be complete without even that delay." Also, "By transmitting deep red light only, this goggle material maintains virtually complete dark adaptation of the wearer's rods while permitting a sufficient degree of cone vision for writing, reading," etc.

The above hints at the belief that rods are insensitive to red light; which is not strictly true. "Actually, in peripheral vision the rods are slightly more sensitive to red light than the cones."[5]

Miles[6] went even further than Chamberlain in stating, "Deep red light definitely advances the rate of dark adaptation beyond that which normally takes place in the presence of darkness." Purveyors of the goggles[10] state: "Ideal for the busy roentgenologist who need not stop to accommodate eyes between fluoroscopic examinations. . . . Provide complete eye-adaptation."

The only real evaluation of goggles we have been able to discover is by Schoen and Dimmick[9] who conclude that twenty minutes with red goggles shortens by seven minutes the time it is necessary to spend in total darkness to attain a stimulus sensitivity of 3.34 log $\mu\mu$ L, equal to "very dark overcast night." The same adaptation without goggles was reached in nineteen minutes.

In order to evaluate red goggles for roentgenoscopy we have run a series of tests using an adaptometer developed by us.[8] This instrument contains five phosphors activated by strontium 90. Their surface brightnesses are as follows:

No. 1	0.060 microlambert
No. 2	0.025 microlambert
No. 3	0.0105 microlambert
No. 4	0.0048 microlambert
No. 5	0.0026 microlambert

These discs become visible at three, five, nine, thirteen, and fifteen minutes respectively as averaged from six observers who viewed the discs at reading distance, having been previously adapted in interiors moderately lighted by daylight plus artificial light. (Considerable spread of adaptation times was seen for different observers, which is expected due to age and other factors.)

Against this standard was compared the adaptation obtained after wearing various red goggles. (Ten observers in all were used, aged from eighteen to sixty-three, averaging forty-five years.) Goggles No. 1 is that of the General Electric Company, No. 2 is that of the Picker X-ray Corporation, and No. 3 is the standard Navy goggles. All use identical polaroid; this was confirmed by densitometer readings, and exposing dental films, from whose wrapping windows had been cut, to twenty-five seconds of artificial light, the films being tightly taped to the polaroid, exposed and developed together. Goggles No. 4, made of cellulose acetate of a somewhat

Fig. 1. Goggles No. 1, 2, and 3 were all used here since they are made of identical polaroid: and it has been shown that the complete opacity of the side walls in the Navy type, (No. 3) is of very slight advantage.[9]

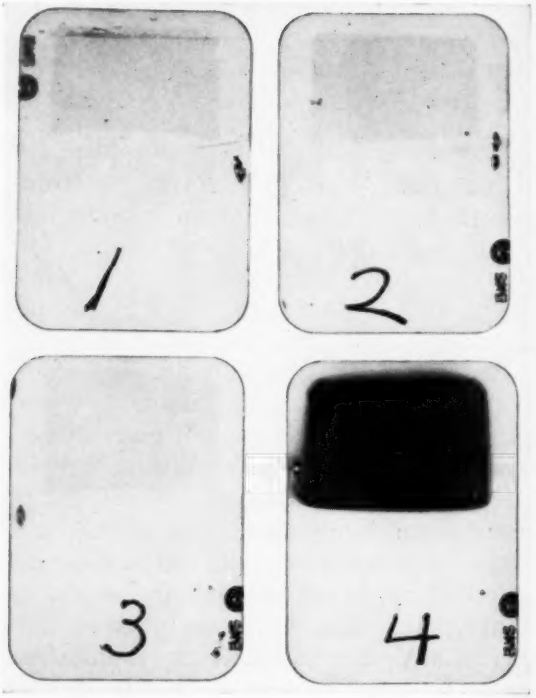

Fig. 2. Although, goggles No. 4 is darker than the others, as shown visually and by densitometer, it transmits light which darkens film much more. Consequently, goggles No. 4 was excluded in these trials, without prejudice or evaluation as to its efficiency.

darker hue, seems to have a different cut-off, as sufficient light passed through to darken the film (Fig. 2).

After at least ten minutes in the noted light conditions, goggles were donned and worn in the same light for twenty minutes. The advantages of peripheral vision were used. Table 1 reports the results under various light conditions.

Not too high a precision should be read into these figures. Several seconds could easily be passed by an individual in making certain that he did see the disc. One observer who saw disc No. 5 in twenty-one seconds probably could have seen it instantly; for a few seconds must of necessity elapse for viewing each disc and signalling

Table I

Light	No. Observations	Disc					
		No. 1	No. 2	No. 3	No. 4	No. 5	S.D. No. 4
Interior. Day and artificial 5 to 15 foot-candles	10 trials 8 observers	30″	58″	2′24″	4′15″	8′15″	2′14″
Interior. Artificial 3 to 4 foot-candles	9 trials 5 observers	7″	16″	50″	1′24″	2′54″	1′29″
Interior. Artificial with and without daylight 3 to 8 foot-candles	10 trials 6 observers	7″	16″	33″	1′	2′21″	26″
Film illuminators 15 to 60 foot-candles	6 trials 5 observers	24″	40″	1′44″	4′20″	5′49″	1′33″
Exterior. Medium sunlight	5 trials 3 observers	1′32″	3′16″	7′17″	11′14″	15′1″	1′44″

a recorder. Moreover, the averages are drawn from a wide range of figures, quite naturally, since variation among individuals is well known, and lighting was not quite constant. Should the eyes merely rove about the room during adaptation great lighting variations occur, as any photographer will testify.

Much better adaptation was achieved at night. The difference probably reflects nothing more than differences in light intensity. Although there is more ultraviolet in daylight, probably this makes no difference in dark adaptation;[7] surely it would not with red goggles, where all ultraviolet is cut off.

A similar quick result is reported when the subject, having achieved adaptation to disc No. 5, lowered his goggles and returned to a moderately lighted room for five minutes, and then returned to darkness.

Rapid re-adaptation was only achieved, however, in moderate lighting. When the observer spent about half of his five minutes looking at roentgenograms (one to four illuminators lit simultaneously, occasionally looking at the illuminator without a film on it) the goggles were sufficient to maintain but a low level of adaptation.

Finally, a short series was run at a more intense illumination. Since some physicians have tried wearing goggles through traffic when directly en route to a roentgenoscopic examination, observations were run after the observer was seated, in daylight, in a closed car. Figures reveal that this is scarcely worth the effort.

In using the adaptometer an interesting phenomenon was observed. After adaptation for a given phosphor was achieved, it was switched off. When switched on again it did not appear for a distinct period, at times for at least a second or two. It was as if vision were cumulative. Inquiry revealed that this is a recognized phenomenon. "Increasing the duration permits the observer to see at lower and lower brightness levels. . . . The effect of increasing the duration of the exposure extends over quite a large range. Unfortunately, data . . . do not extend to very low levels of contrast and consequently we do not have available adequate information relative to the shape of the complete curves relating contrast-thresholds and brightness for different durations of exposure."[7] This is of real significance to the roentgenoscopist. The operator who studies his screen by excessively short bursts with the foot-switch handicaps himself needlessly.

DISCUSSION

Our evaluation of red goggles agrees rather well with that of Schoen and Dimmick, considering the differences in conditions and purposes of the studies. Not so simple is to determine what level of adaptation the prudent roentgenoscopist, given the facts, would choose.

Rather arbitrarily, perhaps, we select the ability to see disc No. 4 on our instrument, or 0.0048 microlambert, as the least adaptation acceptable with which to study the abdomen. This empirically is satisfactory to us, being that stage which would be reached in thirteen minutes without goggles in complete darkness, having started from an interior of moderate lighting. This we suspect is not far from common practice, although some writers advise a twenty minute period. With those broad landmarks and with the warning that averages are subject to great individual variation we come to the following conclusions.

CONCLUSIONS

Red goggles do not give adaptation satisfactory to good roentgenoscopy unless their wearing in light is followed by a period in complete darkness. This is about four minutes if the subject were previously in an interior moderately lighted by daylight plus artificial illumination. In dimmer lighting, as in night interiors, one and one-half minutes are required, whereas in sunlight red filters approach uselessness.

Once adaptation is achieved, the roentgenoscopist who returns with goggles to a room of average lighting can re-adapt in one minute in complete darkness; if, however, he looks at strong light, such as film illuminators, four minutes will be required.

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EDITORIAL

VISCERAL TOPOGRAPHY IN THE LIGHT OF THE ROENTGENOLOGIC APPROACH

IN A comprehensive series of papers which appeared at the turn of the century, the British anatomist Addison codified the information on visceral topography available at the time. He divided the abdominal region into a number of small squares and allotted to the viscera their fixed places in this scheme. Thus, until the advent of the roentgen ray, the opinion prevailed that each organ, thoracic, abdominal or pelvic, has its fixed shape and position, a knowledge of which is necessary in order to recognize deviations. The concept of a "dropped" or "ptotic" viscus has as its corollary the assumption of a "standard" or "normal" position from which organs may stray with resulting clinical symptoms. The literature of the past is replete with descriptions and case histories of generalized visceroptosis, gastroptosis, coloptosis, etc. Even at the present day, surgical procedures are still devised which aim at anchoring organs in their "allotted" location.

It is now more than twenty years since Barclay in Britain, and Moody and his co-workers in this country, set themselves the task of "slaying a beautiful theory with ugly facts" (Barclay). The theory as offered by Addison has been presented. The facts, based on roentgenologic examination of the living, are: that the standards set forth as norms proved to be erroneous, since they were obtained from cadavers. Here many unphysiologic conditions prevail, such as rigor mortis or complete relaxation of the smooth and striated musculature, including the diaphragm. The thorax is in a state of maximal expiration with collapse of the lung, displacement of the heart and elevation of the diaphragm. Embalming and dissecting procedures change the pressure conditions in the thoracic and abdominal cavities and within the vasculature. The elasticity of connective tissue is lost and the fat is solidified. All of these factors stabilize the position of the viscera after death in an unphysiologic location (Lachman). Thus, to express it facetiously: in the dissecting room we study the topographic anatomy of "cadaver man," a "species" that is closely related to, but not identical with living man.

It would seem superfluous to belabor this point any further, if it were not for the fact that modern anatomical and clinical literature frequently ignores the available evidence. Thus, a recent anatomical work analyzes and illustrates topographic findings on abdominal viscera as encountered after opening the abdomen of embalmed cadavers. Several recent publications on cardiology depict the surface anatomy of the heart, including the position of the valves, as originally conceived by LeWald, This author based his topographic studies on findings in formalin-preserved and frozzen cadavers in which heart and lungs had been taken out of the thoracic cavity and the heart returned after metal rings had been inserted from the atrial side in line with the position of the cardiac valves. LeWald's roentgenograms show the heart in an empty chest cage, with the diaphragm maximally elevated to a cadaveric position. His results, therefore, can hardly be accepted as a standard for the normal surface projection of the heart and its valves in the living. Textbooks of physical diagnosis which are interested in teaching the topography of the viscera in the living, neverthe-

less often employ the time honored norms of conventional anatomy.

Roentgen-anatomical studies reveal that physiologic variations make it necessary to qualify every topographic description of an organ by a statement defining the physiologic state of the individual at the time of the examination. Well known are the great variations in the location of the viscera as result of changes in respiratory phase and body posture. Less tangible are positional variations brought about by alterations in tonus, particularly for the stomach and colon. A number of astute clinical observers explain the symptoms of a patient with a low elongated stomach or an intrapelvic position of the transverse colon on a psychogenic basis and assume that success of psychotherapy in these cases is partly due to an improvement in the tonus of the abdominal organs. Even a retroperitoneal organ such as the duodenum, which is generally regarded as stationary in position, shows an excursion of plus or minus two vertebrae, depending on the state of filling of stomach and intestines and on body posture (Friedman).

Many years ago Mills started a fruitful roentgenologic study of the size, shape and location of the viscera with reference to body habitus. He pointed out that there is a constant relationship between certain external and visceral characteristics and suggested that the one type norm of visceral topography be replaced by a multiple type standard which correlates visceral position with physical characteristics of body build. Mills based his preliminary studies on a classification of physical types which today can be regarded as somewhat obsolete. Surprisingly enough, Mills' work has never been followed by a comprehensive study of abdominal visceral topography in terms of modern constitutional evaluation as established by Sheldon, Stevens and Tucker. Here, then, is a wide open field for constitutional research.

As far as the heart is concerned, extensive data are available correlating its size with constitutional factors of height, weight, and sex. Recently, Morris and Jacobs undertook a study on 100 individuals relating cardiac size and configuration to body build, defined in terms of Sheldon's sliding scale. They confirmed the facts which were to be expected from previous work, *i.e.* that the heart of the endomorph, lying on a high diaphragm, is squat, its contours smooth, its transverse diameter and frontal area large and its waist narrow. The heart of the mesomorph, on a diaphragm intermediate in position, is square, its contours angular, its transverse diameter and frontal area large, its waist broad. The ectomorph has a low diaphragm and displays a heart that is narrow and linear, with smooth contours, small transverse diameter and frontal area, and a narrow waist. Occasionally, these authors encountered hearts that appeared to be in the wrong body, *i.e.* that showed a lack of harmony between the configuration of the heart and body physique.

Of greatest interest are two recent roentgenologic studies dealing with the surface projection of the heart on the anterior chest wall. Mainland and Gordon, in a thorough investigation, related the position of the living heart to sternum and costal cartilages marking them with radiopaque brass wires. Their results, statistically evaluated, offer as the most striking feature an unexpectedly low position of the heart in the erect posture as compared with conventional descriptions. Particularly surprising is the location of the inferior cardiac border which is given as crossing the midline 5.5 cm. (later corrected by Mainland to 4.5 cm.) below the xiphisternal joint. The heart of the recumbent living subject, being higher, approximates more closely the conventional projection, but still does not lie as far craniad. Hasselwander, using a quite different approach and apparently being unaware of Mainland's work, studied the surface projection of the heart by means of a combination of roentgen stereoscopy and ordinary photography. Utilizing markers that are visible on photographs and roentgenograms alike, he superimposes

tracings of the two pictures and correlates the cardiac contours with the visible surface features of the anterior chest wall. By this method, he arrives at the conclusion that in deep inspiration the caudal heart margin frequently may be found as low as 5 cm. below the distal end of the xiphoid process. His studies show that the sternal origin of the diaphragm turns downward in inspiration to admit the heart in its caudal motion. This corresponds to a visible protrusion of the anterior abdominal wall in the epigastrium during the inspiratory phase and also furnishes the reason for the otherwise puzzling epigastric pulsation. Hasselwander's beautifully illustrated studies completely confirm Mainland's findings and explain the surprisingly low position of calcified valves which has so frequently been noted. There is still lack of information on the surface projection of the valves in the normal living subject as demonstrated by the angiocardiographic approach. Textbook diagrams on the anatomical position of the valves are in need of replacement.

As far as the location of the lungs in the living is concerned, data have been collected during recent years to upset the timeworn standards. It is now known that the posterocaudal extent of the lungs and pleural cavity may be as low as the transverse processes of the second lumbar vertebra, a fact that may lead to occasional embarrassment in renal surgery (Lachman). Here, again, no detailed studies are available that correlate these findings with body build.

Although the discrepancies between the caudal extent of the lungs in the living and in the cadaver have been known for some time, and although interlobar lines corresponding to the oblique fissures are frequently visible on lateral views, it is only recently that attention has been drawn to the low upper posterior level of the oblique fissures of the lung. The eminent British surgeon, Brock, in his book on the anatomy of the bronchial tree, points out that the conventional projection of the oblique fissures places them too high in relation to the vertebral ends of the ribs, particularly on the right. Their upper limit is generally given as corresponding to the heads of the fourth ribs or the second or third thoracic spinous processes. By contrast, Brock places the upper extent of the oblique fissures at the level of the fifth rib or fifth interspace and only occasionally as high as the fourth rib or third interspace. On the other hand, he finds it quite often as low as the sixth rib or sixth interspace. The line of the fissure commonly coincides to a great extent with the sixth rib, particularly on the right, where it is somewhat lower than on the left. In simple words: the upper lobe reaches farther caudally, and the lower lobe not as far cranially as commonly assumed. The reason for the discrepancy is again to be found in the expiratory collapse of the cadaver lung and in the abnormal elevation of the diaphragm after death. Brock's findings are of the greatest practical importance in the lobar and segmental localization of lesions and their surgery.

Every radiologist is familiar with the positional variations of the gallbladder which became common knowledge soon after the introduction of cholecystography. Barclay calls attention to the fact that in tall, thin women the organ may be found below the crest of the ilium, sometimes overlapping the sacroiliac joint, and occasionally even to the left of the spinal column.

Of the greatest interest to clinicians and anatomists alike is the wide range in the position of the kidneys. Here, at last, we seemed to have an organ whose low position definitely causes clinical symptoms, and nephroptosis generally has been recognized as a clinical entity. Lately, considerable doubts have arisen as to the validity of this concept. As Braasch and Emmett point out, nephroptosis should be considered a relatively normal finding. Only if we can demonstrate definite signs of urinary obstruction or stasis are we justified in regarding the downward displace-

ment of the kidneys as a pathological condition.

Great progress has been made in the field of visceral topographic anatomy during the first half of this century, but many of the findings of roentgenologic anatomy in the living have not been incorporated to the fullest extent in our teaching and in our textbooks. The fluid anatomy of the living which takes account of physiologic and constitutional variations is a fruitful field of research requiring the cooperation of anthropologist, anatomist, physiologist, radiologist, and clinician.

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UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shoreham Hotel, Washington, D.C., Sept. 21–24, 1954.

AMERICAN RADIUM SOCIETY
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: The Homestead, Hot Springs, Virginia, March 14–16, 1954.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Palmer House, Chicago, Ill. Dec. 13–18, 1953.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting: 1954, to be announced.

FIFTH INTER-AMERICAN CONGRESS OF RADIOLOGY
General Secretary, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–30, 1955.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

ARIZONA RADIOLOGICAL SOCIETY
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Elbert K. Lewis, 6337 S. Harvard Ave., Chicago, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
President, Dr. W. P. Stampfli, St. Luke's Hospital, Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reaves, Medical Arts Bldg., Sarasota, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

GREATER MIAMI RADIOLOGICAL SOCIETY
Secretary, Dr. E. H. Bryson, 273 Alhambra Circle, Coral Gables, Fla. Meets third Wednesday of each month at Veterans Administration Building.

HOUSTON RADIOLOGICAL SOCIETY
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

IDAHO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA RADIOLOGICAL SOCIETY
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Willis L. Beeler, M.D., 700 Kansas Ave., Topeka, Kansas. Meets in spring with State Medical Society, and in winter on call.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

KINGS COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Maine Radiological Society
Secretary, Dr. Hugh Allan Smith, Eastern Maine General Hospital, Bangor, Maine. Meets in early spring, June and fall.

Maryland Radiological Society
Secretary-Treasurer, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Maryland.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Will meet at least once a year.

Nassau Radiological Society
Secretary, Dr. Frank Huber, Hempstead, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. J. R. Freid, 1049 Park Ave., New York 28, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April. Annual meeting will be held in May or June, 1953.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. M. M. Thompson, 316 Michigan St. Toledo, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse 416 Pine St., Williamsport. Next annual meeting at Bedford Springs Hotel, Bedford, Penna., May 14 and 15, 1954.

Philadelphia Roentgen Ray Society
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets 6:00 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. A. C. Wyman, 5445—28th St., N.W., Washington, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Chapin Hawley, 927 Carew Tower, Cincinnati 2, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. P. S. Arthur, Young Hotel Bldg., Honolulu 13, T. H. Meets third Friday of each month at a place designated by the Secretary.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. Salomon Silvera, 921 Bergen Ave., Jersey City, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. A. Gordon Ide, 277 Alexander St., Rochester 7, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo.

St. Louis Society of Radiologists
Secretary, Dr. Francis O. Trotter, Jr., 634 N. Grand Blvd., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology, California Medical Association
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Bay Radiological Society
Secretary, Dr. W. H. Graham, 634 East Santa Clara St., San Jose 12, Calif. Meets second Wednesday each month.

South Carolina Radiological Society
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort worth 4, Texas. Next meeting, Dallas, Texas, Jan. 29 and 30, 1954.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1, Wash. Meets fourth Monday of each month from September through May.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. Clifford C. Baker, Harwood Bldg., Scarsdale, N. Y. Meets on third Tuesdays of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6º piso, Bogota, Colombia. Meets last Thursday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IXe, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Wrocław Section Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wrocław, 68 Curie-Skłodowska St., Wrocław, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wrocław.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Măräcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Roentgen-Gesellschaft
Secretary, Dr. Peter Kröker, (22a) Essen-Helsingen, Westpreussenstrasse 21. Meets annually in different towns.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

STAGING IN CARCINOMA OF THE UTERINE CERVIX

A REPLY TO DR. DEL REGATO

The international work on uniform and comparable therapeutic statistics in carcinoma of the uterus originally initiated by the Cancer Commission of the League of Nations has been going on for many years. The problems involved are discussed in the various volumes of the Annual Report on the Results of Treatment in Carcinoma of the Uterus, issued between 1937 and 1952. Annual statements submitted by the collaborators are published in the Report, and these are arranged according to agreed uniform rules. The eighth Report includes statements from 69 collaborators in 15 different countries and covers approximately 82,300 cases of uterine cancer. Suggestions as to modifications of the definitions of the various types of cancer of the uterus and of staging have from time to time appeared in the Report, and have gradually been adopted.

In the AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY and NUCLEAR MEDICINE (April, 1953, *69*, 652–653) is published an editorial by Dr. J. A. del Regato with the title: The International Classification of Carcinoma of the Uterine Cervix. In this very pertinent editorial the author comments on the modified definitions of the stages in cancer of the cervix adopted in 1950. His criticism relates mainly to Stage IV.

The 1950 definitions of Stage IV read as follows:

> Stage IV.—The carcinoma involves the bladder or the rectum, or both, or has extended beyond the limits previously described.

Dr. del Regato's article is of great interest to the Editorial Committee of the Annual Report. It offers a very welcome opportunity to discuss with the collaborators problems of mutual interest. Discussions of this type are a great help to the Editorial Committee in its efforts to establish suitable rules for a uniform classification.

Dr. del Regato draws attention to the agreed general rule on allocation which states that the presence of two or more conditions that characterize a stage does not affect the staging. He considers the expression "or both" unnecessary. He also criticizes the expression "limits previously described" and considers "beyond the anatomical limits of the pelvis" preferable. These two alterations are without doubt well justified. I shall take great pleasure in submitting them to the Editorial Committee for consideration.

The most serious of Dr. del Regato's comments relates to the recommendations laid down in the seventh Annual Report (page 17) concerning the interpretation of bullous edema in the bladder in cases of cancer of the uterine cervix. He quotes, quite correctly, the following sentence: "The Editorial Committee suggests that a bullous oedema should only be considered as a sign of involvement of the bladder if the diagnosis is microscopically verified;" He adds: "more succinctly, this means that bladder invasion must hereafter be verified by cystoscopic biopsy." The Committee admits that the sentence quoted from the Report may be misinterpreted if detached from the preceding paragraph which says: "cases in which on cystoscopy there is no fistula, no ulcerating tumour and no tuberculi visible but which show bullous oedema or ridges and furrows are difficult to classify." Thus, the Committee's discussion was limited to the advanced cases (Stages III and IV) in which cystoscopy reveals only bullous edema or ridges and furrows. The Committee recommends a special method for ascertaining whether or not ridges and furrows should be considered as a sign of bladder invasion. Cases of this type are not mentioned by Dr. del Regato. In the following will be considered only the cases especially mentioned by him, namely, the cases in which cystoscopy reveals nothing but a bullous edema of the bladder trigone.

The Committee's recommendations relating to this category of cases were reasoned as follows: An edema of the bladder trigone may be due to carcinomatous blocking of the lymphatic vessels in the bladder wall, though the possibility of a block of the lymphatic vessels in the paravesical tissue must also be taken into consideration. In addition, an edema of the trigone caused by infection originating from the carcinoma or by infection independent of the cancer may cause a similar picture.

There is no possibility of distinguishing one of these types from the other at cystoscopy. Accumulated experience of the incidence of the various types is urgently required before it can be argued that a bullous edema of the trigone is generally due to neoplastic involvement of the bladder wall. Until sufficient experience

is available the Committee recommends that a bullous edema alone should not be considered as a sign of involvement of the bladder. The Committee has chosen this careful attitude with a view to comparability of the different statements.

It was not intended to recommend a cystoscopic biopsy in all types of bladder invasion, nor even in cases where cystoscopy reveals nothing but a bullous edema. However, the Committee considers it reasonable that a case should be classified as Stage IV if, for some reason, a cystoscopic biopsy is made which shows carcinoma. The advisability of the recommendation is open to discussion. It should, however, be noted that in most cases bladder invasion is clearly indicated by other signs than a bullous edema, such as ridges and furrows, tubercula, ulceration, necrosis and fistula. Cases with bullous edema only in which a cystoscopic biopsy has shown the presence of carcinoma will occur only occasionally.

In summary, the Committee wishes to recommend that a bullous edema alone should not be considered as a sign of bladder involvement; if, for some reason, a cystoscopic biopsy is made which reveals carcinoma the case should be classified as a Stage IV.

We are very grateful to Dr. del Regato for drawing the Committee's attention to the items discussed above. The various points raised will be carefully considered at the next revision of the definitions of the stages in cancer of the uterine cervix.

J. Heyman, M.D.

Professor J. Heyman
Radiumhemmet
Stockholm 60, Sweden

CONFERENCE ON ELECTRONICS AND NUCLEONICS IN MEDICINE

Recent advances in the fields of radiology and motion picture fluoroscopy have resulted in the devotion of two complete sessions of the coming Sixth Annual Conference on Electronics and Nucleonics in Medicine to these subjects. The conference will be held at the New Yorker Hotel, New York City, on November 19–20, 1953. The afternoon session on November 19 will feature papers on three dimensional roentgen-ray motion picture technique, brightness intensification, roentgen-ray microscopy and roentgen-ray isodose plotting techniques. In the evening of the same day, Mr. Sydney A. Weinberg of the University of Rochester and Strong Memorial Hospital will conduct a semi-popular type lecture and panel discussion on "Cinefluorography." Mr. Weinberg will discuss his three dimensional techniques and also the impact that the new brightness intensifiers will have on this type of work. Some films will also be included showing the work which is being carried on in the field of brightness intensification. This session will be open to audience participation.

Three other regular sessions are also planned. One will deal with diagnostic devices such as multi-channel myography instrumentation, a precision stimulus monitor, and location of tumors by means of ultrasonics and also by positron-emitting isotopes. Another session will deal with blood measurements and the last session will consider several fields of great current interest such as the use of electroshock treatment in certain types of formerly fatal heart stoppages, the application of the analogue computer to biological problems and the dispersion of ultrasonic velocity in liquids.

FLORIDA RADIOLOGICAL SOCIETY

At the meeting of the Florida Radiological Society held in April, 1953, the following officers were elected for the year 1953–1954: *President*, Dr. Nelson T. Pearson; *Vice-President*, Dr. A. Judson Graves; *Secretary-Treasurer*, Dr. Hugh G. Reaves.

The Society holds its meetings at the time and place of the Florida State Medical Association in April and the semi-annual meeting in October.

KINGS COUNTY RADIOLOGICAL SOCIETY

At the last regular meeting of the Kings County Radiological Society the following officers were elected: *President*, Dr. M. Wiener; *Vice-President*, Dr. L. Goldfarb; *Secretary-Treasurer*, Dr. S. Maranov, 1450 Fifty-First Street, Brooklyn 19, New York.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

At the annual meeting of the Northeastern New York Radiological Society on May 20, 1953, the following officers were elected to serve for the ensuing year: *President*, Dr. I. J. Murnane; *Vice-President*, Dr. John F. Roach; *Secretary-Treasurer*, Dr. Donald H. Baxter, Albany Hospital, Albany, New York.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

At the recent meeting of the Rocky Mountain Radiological Society held in Denver, Colorado, on August 20, 21, 22, 1953, the following officers were elected: *President*, Dr. W. Walter Wasson, Denver, Colorado; *President-Elect*, Dr. A. M. Popma, Boise, Idaho; *1st Vice-President*, Dr. Angus K. Wilson, Salt Lake City, Utah; *2nd Vice-President*, Robert D. Moreton, Fort Worth, Texas; *Secretary-Treasurer*, Dr. John H. Freed, Denver, Colorado.

A very successful meeting was held with a registration of over two hundred and seventy-five, including guests and visitors.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

POST-GRADUATE LECTURES ON ORTHOPEDIC DIAGNOSIS AND INDICATIONS. By Arthur Steindler, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. Volume IV. Section A: Arthritis and Diseases of Muscles, Bursae Tendons and Fasciae. Section B: Deficiency and Degenerative Diseases of the Locomotor System. Cloth. Price, $9.75. Pp. 312, with 276 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

The volume described is the last of a series of four. It consists of lectures as delivered by the author to his post-graduate students of orthopedic surgery. The series, now completed, is proposed as a guide in orienting the student to the boundary which separates normal and pathological conditions of the locomotor system and, after recognition, the indications for the disposition of the pathological conditions. In it are duplicated the pleasing format and didactic method of presentation used in the three preceding volumes.

The subjects discussed are divided into twelve lectures in the first section: Atrophic arthritis, hypertrophic arthritis, nonspecific arthritis of the spine, pyogenic arthritis, syphilis of bone and joints, inflammatory diseases of muscles, Dupuytren's contracture, diseases of tendons and bursae, with the muscular dystrophies, are covered in an inimitable manner. A didactic outline is presented in which the author assumes the responsibility for all opinions as in classroom teaching.

The second section is divided into five lectures. The subjects covered are the vitamin deficiency status related to orthopedic problems, senile diseases of bone, fibrocystic lesions, avascular necrosis conditions of bone and the neuro-arthropathies.

A master clinician and teacher has completed the presentation of his organized material to the post-graduate student. This last volume could be read with profit by anyone with interest in the subject matter. The need for such an approach to the post-graduate student has long been appreciated. All students of orthopedic surgery will profit by diligent and attentive perusal of this four volume series.

FRANK P. WALSH, M.D.

CONGENITAL DYSPLASIA OF THE HIP JOINT AND SEQUELAE (IN THE NEWBORN AND EARLY POSTNATAL LIFE). By Vernon L. Hart, M.D., F.A.C.S., Assistant Professor of Surgery, University of Minnesota, Minneapolis, Minnesota. Cloth. Price, $5.00. Pp. 187, with 83 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

A very unusual privilege is the fortune of this reviewer. He heard the late author present the material covered in this small monograph at the Detroit Orthopedic Lecture before the Wayne County Medical Society on December 6, 1948, at Detroit, Michigan. The author addressed his plea to family physicians and pediatricians for early recognition and treatment of the congenitally inadequate hip joint.

This little volume contains nothing that is new to the orthopedic surgeon. However, it does contain in a well and logically presented fashion all that is necessary for any reader to know to allow for early recognition of a congenital dysplasia of the hip joint in an infant. His plea for early recognition and, as a logical sequela, the early institution of simple conservative measures of treatment is superbly presented. The possibility of good functional hips for the duration of the infant's life span is the excellently presented reason for his making such an effort.

The reviewer knew the late author and shares his enthusiasm to present this factual knowledge to our colleagues whose responsibility it is to care for our "little people." This easily read small monograph is recommended without qualification to all who care for infants.

FRANK P. WALSH, M.D.

RARE MANIFESTATIONS OF METABOLIC BONE DISEASE. THEIR PRACTICAL IMPORTANCE. By I. Snapper, M.D., Ph. D., Physician and Director of Medical Education, Mt. Sinai Hospital; Clinical Professor of Medicine,

Columbia University College of Physicians and Surgeons, New York City. Fabrikoid. Price, $3.00. Pp. 96, with 18 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

This monograph was given by Dr. Snapper at the Twenty-ninth Beaumont Lecture before the Wayne County Medical Society.

In the introduction he discusses osteogenesis, calcium metabolism, and disturbances of metabolism and diseases of the skeleton, thus laying the groundwork for a better understanding of the subsequent chapters on (1) hyperparathyroidism, (2) multiple myeloma, and (3) hypercalcemia, hypophosphatemia and hypercalciuria in diseases other than hyperparathyroidism.

Dr. Snapper is well qualified to write this monograph; his experiences in China gave him a wealth of material to study particularly as nutrition affects bone metabolism. In the chapter on hyperparathyroidism Snapper says the diagnosis can only be made if the four biochemical signs—hypercalcemia, hypophosphatemia, hypercalciuria and hyperphosphaturia—are present.

In the last chapter, arranged in a table, he lists the changes of calcium and phosphorus metabolism found in different bone diseases.

He gives a good summary of the relatively rare metabolic bone diseases by the discussion of observations on seven patients illustrating the seven different types.

The book is durably bound and well printed. Anyone interested in bone diseases would do well to read this book.

ROBERT C. MOEHLIG, M.D.

DIE KRANKHEITEN DER NASENNEBENHÖHLEN, DER OHREN UND DES HALSES IM RÖNTGENBILD. Von Prof. Dr. Richard Mittermaier, Direktor der Universitäts-Hals-Nasen-Ohren Klinik, Marburg/Lahn. Zweite vermehrte und überarbeitete Auflage. Cloth. Price, DM 66.–. Pp. 232, with 483 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

This is an atlas of typical roentgenograms which represent cross sections of the daily work in roentgen diagnosis in the Throat, Nose, and Ear Clinic of the University of Marburg. There are sections on the anatomic and topographic conditions and very precise instructions regarding the roentgen technique, especially in the position of the patient. The illustrations are exceptionally well done, although some of the American readers would have preferred illustrations in the "negative," similar to the original roentgenograms rather than the diapositive prints which, with two or three exceptions, are shown in this book. Of course, anyone experienced in reading roentgenograms will have no difficulty on that score. There is less loss of detail in the positive reproductions as compared with the original than if so-called negative prints had been made in each instance. In any event, the illustrations are perfectly selected and superbly printed. Numerous line drawings facilitate the reading of many of the roentgenograms. The text is relatively brief but the captions of the various illustrations are long enough to make up for the brevity of the text. Valuable aid of laminagraphy is illustrated in the appropriate cases. This atlas is really a prize volume.

JAMES T. CASE, M.D.

DAS BRONCHUSCARCINOM. Von Doz. Dr. G. Salzer, Doz. Dr. M. Wenzl, Dr. R. H. Jenny, Assistenten, und Dr. A. Stangl, Leiterin des Röntgeninstitutes der II. chirurgischen Universitätsklinik in Wien. Mit einem Beitrag von Dr. O. Mayrhofer, Anäthesist der Klinik. Cloth. Price, $18.60. Pp. 242, with 120 illustrations. Springer-Verlag, Mölkerbastei 5, Wien 1, Germany, 1952.

This book of 143 pages and 99 additional pages of well reproduced roentgenograms and surgical and postmortem specimens is the first comprehensive treatise on bronchogenic carcinoma in the German language. While it is primarily a clinical treatise written by a surgical team from the surgical clinics of the University of Vienna, it is concerned mainly with pathology, symptomatology and diagnosis. Therapy comprises a long chapter; but technical considerations of surgical procedures are not stressed. The beginning of the surgical era for the treatment of cancer of the lung was in 1947 when Denk did the first one-stage pneumonectomy for this disease. The experience of the clinic is based on 1,200 cases seen between 1933 and 1951. There seems little doubt that there is in Austria, as elsewhere, an actual marked inincrease in the number of cancers of the lung (from 9 per cent of all cancers in 1933 to 17.4 per cent in 1950). The occupation did not seem to have any importance in the etiology of the disease. Cigarette smoking may be of some in-

fluence. However, of the small number of women (42 compared with 715 in a part of the series) 30 out of 42 were nonsmokers. Of interest is the fact that patients consulted a physician at an average of 1.8 months after the first symptoms. It took an additional 4.6 months (average) until the physician referred the patient to the clinic. The lack of physical findings in the early stages is emphasized and the absolute necessity of chest roentgenograms in any mildly suspected case is stressed. Most desirable is the chest roentgenogram of the apparently healthy in the later age groups.

The diagnostic features of the roentgen appearance of bronchogenic cancer are well described and 100 pages of excellent reproductions of chest roentgenograms (often with photographs of specimens) offer a really comprehensive roentgen-ray atlas of bronchogenic carcinoma. All other diagnostic means are well described.

The surgical indications and contraindications are well presented. The attitude of this clinic seems to be getting somewhat more conservative because of poor results in questionably operable cases. About 30 pages are devoted to the surgical procedures, anesthesia and postoperative treatment. Roentgen therapy was used in 125 of 727 inoperable cases (203 were considered operable during the same time). The small cell carcinoma seems primarily very responsive to irradiation, but all these patients later died from metastases. Palliative improvement and temporary subjective results make radiation therapy still a worthwhile procedure. No five year arrest by roentgen therapy could be shown. There is probably not even prolongation of life by this therapy.

The fate of patients with cancer of the bronchus is still very discouraging. In 203 resections there was an operative mortality of 21.1 per cent. Five year results after resection are not as yet available. The impression of this group is that the outlook for a patient with this disease is still very poor in spite of progress and that early diagnosis and early operation are the only hope for better surgical results.

The book is well written and superbly illustrated and should be in the library of anyone who is interested in the roentgenological and surgical aspect of this disease.

Hans W. Hefke, M.D.

Annual Report on the Results of Radiotherapy in Carcinoma of the Uterine Cervix. Seventh Volume. Statements of Results Obtained in 1945 and Previous Years (collated in 1951). Sponsored by American Cancer Society, British Empire Cancer Campaign, London, Cancerföreningen, Stockholm, Donner Foundation, Philadelphia, Landsforeningen mot Kreft, Oslo, World Health Organization. Editorial Committee: Dr. J. Heyman (Editor), Stockholm; Dr. M. Donaldson, London; Dr. Joe V. Meigs, Boston. Paper. Pp. 288, with numerous illustrations and tables. P. A. Norstedt & Söner, Stockholm, Sweden, 1952.

This report now includes the statements of sixty-five institutions in fourteen different countries; 70,178 patients with carcinoma of the cervix were seen at these institutions and 65,397 of them (93 per cent) were treated. Only 16 per cent of the patients were in Stage I; 72 per cent of the total cases were almost equally divided into Stages II and III but in the last five years an increase of Stage II cases to 42 per cent has resulted in a relative decrease in the proportion of Stage III cases. The relative five to seven year apparent recovery rate after radiotherapy is 32.6 per cent; this represents a rise from 26 per cent shown in Volume II. When only the last five years of work are taken into account, the relative apparent recovery rate is 38 per cent in Volume VII compared with 36 per cent in Volume VI.

An analysis of the results of the last five years shows a relative apparent five year recovery rate of 64 per cent for Stage I, 44 per cent for Stage II, 25 per cent for Stage III and 9 per cent for Stage IV. The editorial committee of these reports considers it impracticable for the time being to compare the results of surgery with the results of radiotherapy in the treatment of early carcinoma of the cervix, in view of the different methods of selection; radiotherapeutic results have been accepted only from institutions reporting all cases. However, a chart is presented showing the results of treatment of Stage I cases at institutions practicing surgery in "some" cases and the results of other institutions at which only radiotherapy is done.

The report ends with an interesting commentary on follow-up in American institutions: "It has repeatedly been mentioned that in the United States great difficulties in the follow-up are encountered. It is worth mentioning that six of the eleven (contributing) American institutions report 80 per cent more and only one institution reports less than 70 per cent."

J. A. del Regato, M.D.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor; T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Poppel, Maxwell H., Jacobson, Harold G., and Dewing, Stephen B. Value of the lateral mid-line tomogram in encephalography and ventriculography. *Radiology*, Feb., 1953, *60*, 236–240.

By analysis of 62 ventriculograms and encephalograms using lateral midline (sagittal) laminagraphy routinely, the authors demonstrate marked improvement in visualizing the midline ventricular system. The cerebral aqueduct and fourth ventricle are especially well seen when compared with standard lateral views. The routine use of laminagraphy in this regard as well as in delineating other midline intracranial structures is suggested.—*William A. Goodrich, Jr., M.D.*

Gurdjian, E. S., Webster, J. E., and Lissner, H. R. Observations on prediction of fracture site in head injury. *Radiology*, Feb., 1953, *60*, 226–235.

Using 100 freshly dried human skulls coated externally and internally with a strain sensitive lacquer, the authors present an analysis of the most likely sites of linear fractures due to low velocity impact to various parts of the skull. Higher velocity impact tends to produce local depression fractures rather than linear fractures.

Linear fractures tend to occur at a distance and radial to the point of the blow, but, if sufficiently long, may extend proximally to the point of impact. Eight descriptive figures are presented showing the relative frequency of location of fractures due to blows to 12 different areas of the skull.

In general, the more vertically directed fractures are from frontal blows while the more horizontally directed fractures are from more posterior blows. Transverse basal fractures unassociated with vertex fractures occurred in 5 per cent of the skulls subjected to occipital blows and in 2 per cent of the skull subjected to lateral blows—*Martin B. Goodwin, M.D.*

Walker, Exum, Moore, William W., Simpson, James R., and Kristoff, F. Vatnar. Recent advances in the diagnosis and treatment of cerebral vascular accidents. *South. M. J.*, Feb., 1953, *46*, 136–143.

The authors discuss the various disorders which may produce a "stroke." These can often be relieved by surgery or aided by proper care of the patient, hence it is important to make a correct diagnosis. Clinical experience is most important; however, several laboratory procedures have been useful. Routine roentgen studies of the skull, spinal puncture used with caution, ventriculography and cerebral angiography have each, in certain instances, been of considerable aid in accurate localization and demonstration of the lesion. Twenty-six roentgenographic reproductions are included to demonstrate the various lesions and their location.

Surgery is not discussed; however, the importance of ample oxygen is stressed. There are occasions when a tracheotomy may be life saving when there is respiratory difficulty.—*V. L. Peterson, M.D.*

Barton, Richard Thomas, and Thee, Earl John, Jr. Nonchromaffin paraganglioma; report of three cases. *J.A.M.A.*, Feb. 21, 1953, *151*, 619–621.

The authors report 3 very interesting cases of nonchromaffin paraganglioma of the glomus jugulare. This glomus is usually single and found in the adventitia of the dome of the jugular bulb immediately below the floor of the middle ear. It is histologically identical with the carotid body. To date 47 of these jugular body tumors have been reported.

There is a close similarity in the clinical features of the cases reported including those of the authors. The chief characteristics are: (1) chronic draining ear treated over a long period with little change; (2) tinnitus with roaring or pressure sensation in the ear; (3) a vascular polypoid tissue mass in the external auditory canal, usually with a history of previously attempted removal with moderate or severe bleeding; (4) loss of hearing. Progressive symptoms of pain, partial or complete paralysis of the adjacent cranial nerves, and bleeding of the tumor mass appear as the tumor progressively enlarges. Roentgenograms in well developed cases show erosion of the petrous pyramid on the affected side and varying degrees of sclerosis of the mastoid area.

The treatment of these neoplasms is surgery, but complete exenteration may be difficult or impossible due to abnormal hemorrhage. The authors doubt if radiation therapy is helpful primarily but gave postoperative treatment to 2 of their cases. No recurrences have developed in these cases treated with irradiation.

These tumors are usually benign with only 4.5 per cent of the reported cases showing malignant changes with distant metastases.—*T. D. Allison, M.D.*

Neck and Chest

Schoen, Detlev. Hartstrahltechnik und Feinfokusröhre in der Diagnostik des Kehlkopfes. (High voltage technique and small focus tube in the diagnosis of the larynx.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1953, *78*, 170–173.

High voltage technique with a small focus tube improves the demonstration of laryngeal physiology and pathology in roentgenoscopy as well as in roent-

genography. A voltage of 125 kv. is used by the author.

This technique permits increase of the size of the image by increasing the distance between the object and the screen or the film. An 1.8:1 magnification was found most feasible.

The physiological movements of the vocal cords and of the sinus of Morgagni can be well demonstrated by using the established procedure of pronunciation of the vowels I and O or U.

Laminagraphy, however, is still the most reliable means of roentgen diagnosis of soft tissue changes of the larynx.—*Hans W. Hefke, M.D.*

GURDJIAN, E. S., and WEBSTER, J. E. Stroke resulting from internal carotid artery thrombosis in the neck. *J.A.M.A.*, Feb. 14, 1953, *151*, 541–545.

Internal carotid artery thrombosis in the neck may be more common than is suspected. The authors report 30 cases seen in four years; 3 also had common and external carotid involvement. Angiography is essential for diagnosis.

The clinical picture may be identical with that seen in strokes. There are three main types: sudden onset of hemiplegia or hemiparesis with or without unconsciousness; repeated attacks of minor and short-lasting paralysis; and slowly progressive hemiplegias. A combination of headaches with progressive disability involving one-half of the body may simulate a mass lesion.

The etiology is obscure. The condition appears to be due chiefly to insidious factors produced by atheromatous degeneration of the blood vessels. Its incidence is greatest in the upper middle age, but there were 8 patients under fifty, including 2 under thirty. Only 4 patients of the entire group were women. In 19 cases the lesion was on the left side, as against 11 on the right.

Diagnosis depends chiefly on angiography or neck dissection. Accurate diagnosis by other means was impossible. Indications for angiography are: sudden onset of hemiplegia or hemiparesis with clear spinal fluid under normal pressure; or repeated attacks of short-lived hemiplegia or hemiparesis. The angiographic patterns about the carotid bifurcation are typical. The internal carotid artery may be completely shut off at its origin from the common carotid; there may be a small nubbin of patent artery, and in others the obstruction occurs higher up in the neck. The latter pattern may be open to question, but the authors feel such a pattern does occur.

In 15 patients a portion of the thrombosed internal carotid artery was excised. Marked atheromatous changes were found at the bifurcation. In some the artery past the bifurcation was small, in others swollen and pulseless. Nine patients had an organized clot. In 2, atheromatous masses extended into the lumen. Microscopic examination showed no evidence of thromboangiitis obliterans in any case.

Treatment is generally unsatisfactory. Conceivably the condition may occur with few or no serious sequelae, and the diagnosis considered to be a spasm or cerebrovascular disease of mild degree. Excision and ligation of the internal carotid artery was carried out in 15 cases; these patients have not been followed long enough to compare them with nonoperated patients. In every case the authors have performed a bilateral stellate block, but this has not been encouraging. Rehabilitation is important. They have not used anticoagulatnt therapy, and have not seen a patient early enough to attempt excision of the thrombus. They have not ligated the carotid intracranially.

The prognosis is uncertain. Of the 30 patients, 2 have died, 8 appear to have recovered satisfactorily, 10 have varying degrees of disability, and 9 are hospitalized because of severe mental or bodily disability. One patient was lost to follow-up.—*Arthur A. Brewer, M.D.*

AIKEN, DAVID, and SMITH, HERBERT F. Pneumomediastinum and pneumothorax following block dissection of the neck. *Brit. J. Surg.*, Jan., 1953, *40*, 325–331.

The authors report on 6 cases of pneumothorax and 2 cases of pneumomediastinum which followed block dissection of the neck for malignancy. The gravity of the pneumomediastinum is stressed and accurate diagnosis by the use of physical and roentgenologic examination is urged.

They dismiss as the mode of entry of air into the mediastinum injury to the mucosa of the respiratory tract, injury to the apical pleura, or pulmonary interstitial emphysema produced by rupture of the alveoli. They believe that the air enters the mediastinum along the carotid sheath, and that the stump of the ligated jugular vein acts as a ball valve, admitting air during inspiration and preventing its escape on expiration. This mechanism is aggravated by the increase of negative pressure during inspiration with endotracheal anesthesia.

The authors reproduce the roentgenogram of a patient with pneumomediastinum showing air present along the carotid sheath to the operative site. Following accumulation in the mediastinum the air may extend as tension increases into the opposite side of the neck, along the aorta, into the retroperitoneal space, or it may rupture the mediastinal pleura, producing homolateral, contralateral or bilateral pneumothorax.

The authors emphasize that treatment of a pneumothorax when present may prove insufficient if pneumomediastinum exists.—*Lawrence A. Davis, M.D.*

RUSSELL, J. Y. W. Spontaneous perforation of the esophagus. *Brit. J. Surg.*, Jan., 1953, *40*, 312–318.

Spontaneous rupture of the normal esophagus is extremely rare. The author presents a full discussion of the etiology, pathology and treatment of this condition. The onset is sudden and acute and must be differentiated from a rupture of a peptic ulcer. Roentgenologic examination is of great value in diagnosis. A pneumothorax with associated basal effusion or broadening of the mediastinum may be seen. There may be emphysema in the root of the neck. A barium swallow is recommended if the condition is suspected. Leakage of the barium will immediately confirm the impression. If a pleural effusion is present and the diagnosis is still in doubt, aspiration with analysis of the fluid for food and acid should be done.

The author presents the case of a thirty-five year old woman with spontaneous rupture on whom the diagnosis was made and followed by successful closure of the tear in the cervical esophagus.—*Lawrence A. Davis, M.D.*

Lester, Charles W. Deformities of the thorax of congenital or developmental origin. *J. Pediat.*, Feb., 1953, *42*, 195–204.

The author's purpose is to present cases or conditions of chest deformities that can be alleviated by surgery, in an attempt to circumvent future psychological and pathological handicaps. Attention is paid to two types of deformities: (1) of congenital origin, where the deformity is due to absence or malformation of bony structures; and (2) of developmental origin, where the bones are apparently normal and the deformity is probably caused by abnormal growth and pull of the attached muscles.

In the first group rudimentary or absent ribs may cause deformities. This is due mainly to the fact that muscles which normally attach to these ribs are also absent. Such an anomaly usually does not require surgery as the normal growth of the child compensates for the deformity. Fused ribs, principally those that are fused posteriorly, may cause marked deformities because of the increased relative growth of the spine and rest of the thorax, resulting in scoliosis. In these cases best results are obtained when surgery is initiated early. The author points out that when one anomaly is present, others are likely to be found. A patient is described who had absence of one rib, fusion of several other ribs, hemivertebrae, defective scapula, clubfeet, and spina bifida of both the dorsal and lower lumbar spine.

In the second group, the various protrusion deformities, of which pigeon breast is one, and the funnel chest are included. These protrusions may be in the midline or to the right or left of the sternum. Midline deformities are further divided into those in which the midpoint of the sternum is most prominent and those in which the xiphoid is most prominent. The etiology is obscure, but, theoretically, the growing force of the ribs restricted by muscular attachments could cause a buckling at the costochondral junctions. If the central tendon of the diaphragm keeps pace with the rib growth, the xiphoid would be prominent. If not, the sternum will produce the arched deformity. If overgrowth occurs in the ribs which are below those that attach to the sternum, a transverse groove deformity results. These deformities are usually not noticed until the child is over five years of age. Physiological effects include respiratory infections, failure to gain weight, easy fatigability, dyspnea and tachycardia. Psychological effects may overshadow the physiological ones. Surgical correction is indicated if the patient earnestly desires it or if respiratory or cardiac symptoms exist. The results are often dramatic. Correction of the protrusion deformity is based on one of the principles of thoracoplasty, *viz.*, that a rib resected subperiosteally will regenerate in the position taken by the stripped periosteum. When numerous ribs have to be resected, a second-stage procedure should be done because of paradoxical respiration which may occur. Details of the operation are described adequately. Patients have little reaction to the surgery and they are usually out of bed the next day and home in a week.

Funnel chest is likewise produced by abnormal muscle pull. The deformity consists of a funnel-shaped depression of the anterior chest wall with the apex of the funnel at the xiphoid. The major cause is the pull exerted by a short central tendon of the diaphragm, which draws the xiphoid backward during inspiration in a direction opposite to its normal movement. This deformity is associated with cardiac displacement, bronchitis, round back, poor posture, underweight and underdevelopment. Physiological effects are also present where the deformity is severe. The treatment is surgical. In early infancy the operation is simple, consisting of detachment of the xiphoid from the gladiolus and severance of the substernal ligament. Later, more radical procedures are required. These are described in detail. A major complication of surgery is perforation of the pleura necessitating tracheotomy; therefore, an experienced anesthetist should be present.

The author includes many reproductions of excellent roentgenograms and photographs illustrating the deformities to good advantage.—*Leslie L. Lemak, M.D.*

Patey, David H., and Nurick, A. W. Natural history of cystic disease of breast treated conservatively. *Brit. M. J.*, Jan. 3, 1953, *1*, 15–17.

Sixty-five patients observed in nineteen years among 535 consecutive patients with breast pathology had cysts of the breast. Follow-up study of this group (27 patients for more than five years and 38 patients for five years or less) led to discovery of only one cancer. This cancer developed in an opposite normal breast.

The authors believe that cystic disease of the breast is a common, clearly defined clinical entity,

They suggest that opinions of others to the effect that cystic disease increases liability to cancer are based on indirect histological evidence and animal experimentation. Mastectomy as a form of therapy is judged to be too mutilating and to be illogical as a unilateral extirpation for a bilateral disease. Surgery is advocated if there is any suspicion of intracystic growth. The diagnosis of chronic mastitis is regarded as an obsolete one previously harbored in the minds of physicians to cover a nonexistent entity and to have "befogged breast pathology and diagnosis far too long."

Conservative treatment by aspiration is offered as a safe efficient method of management of cystic disease of the breast.

The following signs of intracystic nodules should be sought:

1. Blood in aspirated cyst fluid.
2. Residual nodule after aspiration of cyst.
3. Refilling of the cyst within a few weeks.
4. Presence of tumor cells in aspirated fluid.

If such evidence suggests a nodule in a cyst, surgery is done without delay.—*John W. Turner, M.D.*

Di Rienzo, S. Fisiopatología de la tos. (Physiology and pathology of cough.) *Radiología*, Panamá, Dec., 1952, *3*, 9–20; also Physiopathologie des Hustens. *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Jan., 1953, *78*, 1–14.

According to the teaching of physiologists, cough is a forcible expiration. The author, on the basis of bronchographic findings and observations of others, contends that coughing is primarily a function of the bronchi and trachea. He bases his statement on the following phenomena noted during bronchography:

1. Stretching of the bronchi at the onset of coughing.
2. Segmental narrowing of the bronchial lumen with localized folding of the bronchial mucosa. The narrowing is most pronounced at the sites of bifurcation of a segmental bronchus.
3. A prolapse of the mucosa and invagination.

The changes mostly involve the bronchial and tracheal mucosa and extend from the bronchioles to the glottis.

The author's observations of an active contraction of the bronchi lead him to revise the concept of the production of bronchiectasis. He distinguishes two types: the reversible type which shows at least partial ability to contract during coughing, and the irreversible type, in which all contractibility is lost and consequently there is inability to expel secretions.

The author also observed bronchial contractions during coughing limited to a single lobe or a lung segment. Localized widening of the bronchial lumen during cough was noted, this being due to increased pressure peripheral to a narrowed bronchial segment. A bronchial lumen of 1 cm. width decreases during cough to one of a few millimeters. This causes a 500-fold increase in intrabronchial pressure as compared to pressure present during normal inspiration.

This increased pressure is the cause of emphysema and when an emphysematous bleb ruptures, a tension pneumothorax develops. Abolishing the cough reflex will relieve the increased intrabronchial pressure and the tension pneumothorax.

The same phenomenon causes bronchiectasis and increase in size of lung cysts and cavities.

The aforementioned observations are based on bronchograms with spot exposures made during inspiration and cough. Numerous excellent reproductions demonstrating the changes described illustrate this paper, which should be of particular interest to physiologists and chest specialists.—*Karol E. Matzinger, M.D.*

Canada, Wilma Jeanne, Goodale, Fairfield, Jr., and Currens, James H. Defect of the interatrial septum, with thrombosis of the pulmonary artery; report of three cases. *New England J. Med.*, Feb. 19, 1953, *248*, 309–316.

Three unusual cases of thrombosis of the pulmonary arteries in patients with large interatrial cardiac defects are described. No relation between the pathological conditions was found. The hemodynamics in the presence of both conditions may explain some of the clinical findings. The atrial defect might increase the longevity of the patient who develops pulmonary artery thrombosis.

The 3 cases presented clinical evidence of interatrial defect. The pulmonic second sound was accentuated. The cardiac shadow showed gradual enlargement. The aortic shadow appeared relatively small and there was enlargement of the cardiac contour below and to the left of the aorta.

All the cases had symptoms and findings suggestive of pulmonary emboli. There were cough, increasing dyspnea and attacks of chest pain. One case had bloody sputum. All cases showed typical roentgen findings of pulmonary artery thrombosis. The main pulmonary arteries were tremendously enlarged. The outer third of the lung fields showed less than normal vascular shadows.

The autopsy findings were rather uniform as regards the extent of the pulmonary artery thrombosis. The combination of clinical, roentgenographic and autopsy findings produced interesting hypotheses but no final conclusions.—*E. C. Baker, M.D.*

Díaz, C. Jiménez, Albert, C., Barrantes, V. L., Lahoz, F., Salgado, L., and Lahoz, C. New roentgenographic technique in bronchial asthma. *J.A.M.A.*, Nov. 29, 1952, *150*, 1297–1298.

The mobility of the thoracic cage and diaphragm in expiration and inspiration is utilized in a technique by which the authors evaluate pulmonary function. Two films are exposed, one in full inspiration and one in deep expiration. These are then superimposed and the positions of clavicles, ribs and diaphragm of the latter are traced upon the former.

In normal individuals the movement of the diaphragm prevails over that of the ribs and clavicles. In asthma, (a) the diaphragmatic movement may be diminished or abolished with increase in rib and clavicle movement, (b) thoracic expansion may be limited and diaphragmatic movement maintained but the clavicles display increased mobility, (c) a third group shows rigidity of both diaphragms and ribs but complementary muscles are brought into play and clavicular respiration takes place.—*I. R. Berger, M.D.*

Bachman, Arnold L., Hewitt, William R., and Beekley, Henry C. Bronchiectasis; a bronchographic study of sixty cases of pneumonia. *A.M.A. Arch. Int. Med.*, Jan., 1953, *91*, 78–96.

This is a report of the study of the bronchi in 60 consecutive cases of acute pneumonitis occurring in young adults without a history of previous pulmonary disease. The purpose of the study was to obtain information concerning (1) the occurrence of bronchial abnormalities, (2) their nature, (3) the course of disease in patients showing bronchial involvement, and (4) the role of atelectasis in the formation of bronchiectasis.

The diagnosis of pneumonia was made and confirmed by clinical, laboratory and roentgenographic means. Bronchographic study was made on all the patients and bronchoscopy was performed in 11 cases which showed bronchial abnormalities. Bronchography was done with lipiodol after the acute febrile phase of the disease had subsided and while infiltrations were still present on the roentgenogram, usually as early as one week after the onset of the pneumonia.

Clinically, all of the patients had a cough productive of between 50 and 200 cc. of sputum of a greenish or mucopurulent appearance in twenty-four hours. Physical signs were variable and changed from day to day. The roentgenograms all showed evidence of segmental involvement of varying degree with associated atelectasis in 38 of the 60 cases.

As a result of the bronchographic studies it was found that bronchial abnormalities occurred early. Twenty-five of the 60 patients showed varying degrees of bronchopathy. Bronchial involvement was demonstrated in 13 of 16 patients with streptococcal pneumonia and in 9 of 30 patients with primary atypical pneumonia.

It has been suggested by others that atelectasis is a requisite for the development of bronchiectasis. The authors found that both atelectasis and bronchiectasis resulted from a common etiologic factor, namely, inflammatory changes in the bronchial walls following infection. All of the 11 patients who were bronchoscoped showed evidence of bronchial infection. Bronchographic studies of these patients showed mild bronchial abnormalities in 6 and definite bronchiectasis in 5.

The bronchial abnormalities which were demonstrated in this group were reversible in practically all of the cases. The rapidity of the return to normal or nearly normal depended upon the degree of damage to the bronchial wall by the inflammatory process. The return to normal was delayed as long as four months in a few of the cases. None were followed long enough to prove conclusively the permanence of the reversal.—*Gerald Lavner, M.D.*

Saslaw, Samuel, Prior, John A., and Wiseman, Bruce K. Varicella pneumonia. *A.M.A. Arch. Int. Med.*, Jan., 1953, *91*, 35–42.

Three cases of pneumonia of marked severity occurring as complications of chicken-pox are reported. Primary varicella pneumonia is rare. Pneumonitis in which the varicella virus appeared to be the causative agent has been reported in only 8 cases.

The patients were adults afflicted with chicken-pox who developed respiratory symptoms and evidence of severe pneumonia. Sputum studies excluded the ordinary bacterial pneumonias, and serologic studies failed to reveal evidence of atypical pneumonia, Q fever or psittacosis. Roentgenograms of the chest showed bilateral diffuse nodular infiltrations which were similar in the 3 cases but were not characteristic of any definite pathologic process. The pulmonary infiltrations cleared dramatically with improvement in the skin lesions.

In summary, chicken-pox which is usually a benign disease may be associated in adults with a severe virus type of pneumonia which clears with amelioration of the skin lesions. Supportive therapy is of prime importance. Antibiotics are used to prevent secondary bacterial complications rather than for a speific action on the varicella virus.—*Gerald Lavner, M.D.*

Peltzer, F. Über die Faktoren, die man für die häufige Erkrankung des rechten Mittellappens der Lunge geltend macht. (On the factors which are made accountable for the frequent involvement of the right middle lobe of the lung by disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Jan., 1953, *78*, 27–37.

The following factors are thought to account for the frequent involvement of the right middle lobe of the lung by a disease process:

1. The relatively large surface of the right middle

lobe with abundant subpleural tissue and a short bronchus which facilitates the spread of a pneumonic process.

2. The distribution of lymph nodes surrounding the right middle lobe bronchus. Both tuberculous and nonspecific lymphadenitis can cause compression of the bronchus or its medial or lateral branch with atelectasis. This occurs most often in childhood, is followed by re-expansion of the lobe and only later, usually in late adult life, is followed by a chronic nonspecific pneumonic process with chronic cough, intermittent hemoptysis and pain in the right anterior chest. There is usually a history of recurrent pneumonias. The frequency of this syndrome some authors to coin the term "middle lobe syndrome."

3. The respiratory mechanism in the right middle lobe is predominantly costal, and rigidity of the chest wall in older poeple together with pleural adhesions might be responsible for the frequent occurrence of the middle lobe syndrome between fifty and seventy years of age.

The typical appearance is illustrated by reproductions of several roentgenograms and bronchograms, showing narrowing of the middle lobe bronchus with bronchiectasis, complete obliteration of the bronchus by scar formation and in one case of chronic middle lobe pneumonia with operative control, a lack of filling of the bronchus due to thick secretions.

Primary new growth of the right middle lobe is very rare; of 1,200 cases of bronchogenic carcinoma in Brock's series, it was found only 8 times. Stangl found in over 1,200 cases an incidence of about 3 per cent.—*Karol E. Matzinger, M.D.*

Friedman, Paul S. Radiologic contributions to the management of pulmonary tuberculosis. *Radiology*, Feb., 1953, *60*, 202–209.

Roentgen study plays an important part in the prognosis and management of pulmonary tuberculosis. Demonstration of the lesion is the first step. Once this is accomplished, the etiologic basis must be established and nontuberculous disease excluded. The extent and pathologic characteristics of the lesion are evaluated and specific contributions may be made to management.

The lesions may be divided into primary and reinfection types. The first-infection type, seen usually in children, is characterized by single or multiple pulmonary foci, regional pleurisy, lymphangitis, and regional lymphadenitis. The reinfection lesions may be subdivided into (1) exudative, (2) caseous pneumonic, (3) fibrotic, (4) fibro-exudative, and (5) fibrocaseous.

Specific contributions to the prognosis and management of each type of lesion are discussed. Search for cavity may require laminagraphy in addition to conventional study and examination in multiple varying angle views. Tuberculous cavities must be differentiated from bullae and bronchiectatic cavities. In the management of pneumothorax, it is important to note whether a patent cavity is decreasing in size. The presence of thickened interlobar pleura and pleural adhesion must be determined and bronchial torsion and obstruction must be recognized when it is present. During re-expansion periodic roentgen evaluation is essential.

According to the author, it is not necessarily true that bilateral pulmonary tuberculosis is a contraindication to unilateral throacoplasty or resection. He considers unilateral cavitary disease with contralateral bronchogenic dissemination an indication for unilateral collapse or resection therapy.—*Arno W. Sommer, M.D.*

Perkins, Rex B., and Bradshaw, H. H. Pulmonary infarction mistaken for bronchogenic carcinoma. *J.A.M.A.*, Feb. 14, 1953, *151*, 545–548.

Any unusual or abnormal shadow on a chest roentgenogram which cannot be satisfactorily explained may represent one of the roentgen manifestations of early bronchogenic carcinoma. Mass survey methods and incidental chest examinations are disclosing silent lung lesions in increasing numbers. When diagnostic procedures fail to provide an adequate explanation for the lesion, exploratory thoracotomy is properly done with increasing frequency.

Since carcinoma is the great imitator of other pulmonary conditions, the reverse must also be true: benign lesions may often simulate malignancy. Pulmonary infarction is one of these.

Two such cases in which thoracotomy was unnecessarily done are reported in detail. In one the lesion was a round mass 2 cm. in diameter in the inferior tip of the right upper lobe. The cause of the infarct was not found. The second case presented an apparent hilar mass (found at surgery to be a localized dilatation of the pulmonary artery), with distal atelectasis of the right middle lobe. The atelectatic segment was resected, and showed thrombosis of the pulmonary vessels with organization and infarction. The patient died suddenly forty-four hours postoperatively. At autopsy an embolus was found in the artery to the right upper lobe, and the right deep calf veins were thrombosed. In this case the infarct was due to embolism from the so-called bland or quiet venous thrombosis of the lower extremity which is the usual source. Such a thrombosis may be asymptomatic and go unnoticed by the patient and undiagnosed by the physician.

It is suggested that prior to exploration of a suspicious lung lesion, deliberate consideration be given to the diagnosis of infarct. History and physical examination should routinely include attention to the lower extremities, the heart, and other sources of emboli. Finally, increased use of angi-

cardiography should be effective in making the diagnosis clearer in many cases.—*Arthur A. Brewer, M.D.*

Russo, P. E., and Cavanaugh, C. J. Diagnosis of pulmonary metastases; a study of 105 cases. *Radiology*, Feb., 1953, *60*, 198–201.

A study is presented of 105 cases of authenticated pulmonary metastases, representing 56 female patients and 49 male patients. The preponderance of females was influenced by the incidence of breast cancer, and by its tendency to metastasize to the lungs.

There were 42 cases (including 21 cases of breast cancer) in which the malignancy originated in the genitourinary system. Gastrointestinal malignancies included 11 cases. Other lesions followed in this order of incidence: lymphoblastoma, skin malignancies and melanoma, soft tissue sarcoma and respiratory carcinoma. Nine cases were classified "miscellaneous," and in 12 cases the primary site was unknown.

The diagnosis of pulmonary metastases may be impossible without a biopsy, and the site of origin may be difficult to determine, even at autopsy, when tumors of highly undifferentiated cell types involve multiple organs.

Chest roentgenograms aid little in establishing the primary site; when metastases are suspected, further investigation of most probable primary sites is indicated, the genitourinary tract and breast being especially important.—*Lynne J. Taylor, M.D.*

Andersen, Howard A., Holman, Colin B., and Olsen, Arthur M. Pulmonary complications of cardiospasm. *J.A.M.A.*, Feb. 21, 1953, *151*, 608–612.

The authors reviewed 63 cases of pulmonary complications found in a series of 601 cases of cardiospasm. They emphasize the importance of recognizing and treating cardiospasm as aspiration of esophageal contents is, in their opinion, the chief causative factor for the pulmonary pathology.

Aspiration pneumonitis comprised 75 per cent of these cases with a considerable variation as to location and extent of the lung tissue involved. A diffuse nodular process was typical with the middle third of the right lung predominantly involved. Three cases of pulmonary fibrosis in this series were considered to be the end result of aspiration pneumonitis. Lung abscess was seen in 1 patient. Bronchiectasis was diagnosed in 5 cases although follow-up bronchograms were not made. Five patients were classified as tuberculous but the authors state that in patients with cardiospasm the virulence of acid-fast organisms should be proved, as saprophytic acid-fast organisms were common sputum findings in these cases. Asthmatic episodes were noted in 4 patients with relief of the symptoms in 2 following successful treatment of the cardiospasm.—*T. D. Allison, M.D.*

Holman, Emile, Gerbode, Frank, and Purdy, Ann. The patent ductus; a review of seventy-five cases with surgical treatment including an aneurysm of the ductus and one of the pulmonary artery. *J. Thoracic Surg.*, Feb., 1953, *25*, 111–142.

The potential hazards of a persistently patent ductus arteriosus are retardation in physical and perhaps mental development, cardiac dilatation and decompensation, and bacterial endocarditis and endarteritis.

The patent ductus is likened to other arteriovenous fistulas in that its effects are dependent upon the deflection of a large volume of blood from the arterial vascular bed with its high pressure directly into the pulmonary vascular bed, which has a lower pressure. The increased volume of blood, flowing into the pulmonary circulation via the ductus, increases the cardiac output of the left ventricle. The short circuited blood serves no purpose and may be considered parasitic upon the normal circulation.

The volume of blood shunted through this fistula is controlled by the size of the ductus and by its distensibility. Cardiac failure may occur at an early age if the ductus is large and easily distensible. As the child with a patent ductus grows, the lower resistance imposed by the pulmonary circulation, as compared with that of the systemic circulation, will attract a progressively greater volume of blood into the shorter circuit, resulting in progressive dilatation of this shorter circuit including the ductus and the left heart. The progressively increasing blood flow through the shorter circuit is limited by two factors: the innate rigidity of the ductal wall and the increasing fibrosis of the pulmonary capillaries incident to the high pressure of the systemic circulation. These two factors may reduce the tendency for an increasing volume of blood to flow through the ductus and are operative in delaying the cardiac symptoms to adulthood.

It is recommended the patent ductus arteriosus be closed by operation if it remains patent beyond five years of age. Should any of the hazards of the disease appear before that time, operation should not be delayed. In this series one child of five months with incipient heart failure was operated upon. Bacterial-endocarditis in a patient of seven years was cured by ligation of the ductus. An aneurysm of the ductus occurred in an eleven year old patient whose ductus had been ligated twice previously and was accompanied by an antibiotic resistant bacteremia. It was cured by division of the ductus at the site of the aneurysm. A fourteen year old patient had an aneurysm of the pulmonary artery opposite the entrance of the ductus. The bacteremia was controlled with antibiotics and ligation of the ductus and wrapping of the aneurysm with cellophane has stayed the latter process. Only 8 of the patients were treated by division of the ductus, while the rest of

the 75 were ligated. In this series there was 1 death due to anuria incident to blood transfusion.—*Paul C. Olfelt, M.D.*

Hedman, Christian, Lind, John, and Wegelius, Carl. Changes in the heart silhouette as studied by angiocardiography. The share of the left auricular appendix in the frontal heart silhouette. *J. Faculty of Radiologists*, Jan., 1953, *4*, 190–192.

During the last fifteen years conflicting statements have appeared in the literature as to the part played by the left auricle and its appendix in the formation of the left cardiac border in the postero-anterior projection. Whereas Roesler thought that the left auricular appendix may form a part of the left cardiac border, C. H. Lauvry and his co-workers in 1936 found not a single case in their series, following injection of contrast medium into the heart. Dotter and Steinberg in 1951 were unable to decide whether or not the left auricle formed a part of the left cardiac border in frontal angiocardiograms. They pointed out that a small segment of the left cardiac border, lying directly beneath the pulmonary artery and its left main branch, is generally supposed to be due to the left auricular appendix. The superimposition of the opacified pulmonary veins, however, usually obscured the left auricular appendix, which was therefore rarely seen.

The authors' investigations were carried out on 5 normal children aged between eighteen days and five years. The angiocardiograms were made in two planes with about 10 exposures per second, each being synchronized with the phase of the cardiac cycle, by means of electrocardiography. The exposure times were 0.02 second. From their investigations, they conclude that it would appear that the phase of the cardiac cycle determines whether or not the left auricular appendix will form a part of the left cardiac border. The left auricular appendix is marginal during auricular diastole, but not during auricular systole. The roentgenographic appearances, therefore, must be correlated with the phase of the cardiac cycle. It seems likely that the inconstant findings previously described were due to an insufficient number of exposures and to the lack of correlation between exposure and the phase of the cardiac cycle. Furthermore, no account of age was taken in the publications quoted. In the authors' cases, all the subjects were under five years of age and the examinations were done in the supine position. Children have a relatively large left auricle and the heart is more transverse in the supine position. The middle cardiac arch is also more prominent in the supine position, and all these factors may have affected the prominence of the left auricular appendix. In one case with proved mitral stenosis an auricular dilatation, the authors were able to demonstrate that the left auricular appendix was marginal in both systole and diastole.—*Samuel G. Henderson, M.D.*

Goodwin, J. F., Wynn, Allan, and Steiner, R. E. Ebstein's anomaly of the tricuspid valve. *Am. Heart J.*, Jan., 1953, *45*, 144–158.

The malformation of Ebstein's anomaly consists of fusion of the leaflets of the tricuspid valve into a membrane which extends downward into the right ventricle and divides that chamber into two portions —a proximal auricular portion and a distal ventricular portion. The foramen ovale is often anatomically and functionally open, or there may be an atrioseptal defect. The malformation results in great dilatation of the right auricle, impairment of the action of the right ventricle, and therefore of pulmonary artery blood flow. Up to date 32 cases have have been recorded.

The authors report a case of Ebstein's syndrome in which diagnosis was made during life and confirmed at autopsy.

The three conditions with which this form of congenital heart disease is most likely to be confused are pulmonary stenosis with normal aortic root and with interatrial communication with right-to-left shunt; tricuspid atresia; and the tetralogy of Fallot. In the severe cases, confusion with the tetralogy is unlikely, in view of the considerable cardiac enlargement in Ebstein's disease.

Roentgenologically in the extreme form of Ebstein's syndrome, the cardiac silhouette may be almost diagnostic, if a pericardial effusion is excluded. The very large globular cardiac shadow, with great enlargement of the right auricle, feeble pulsations over the right ventricle, poorly visualized pulmonary arteries, and underfilled lung fields have been described by numerous authors. In tricuspid atresia the heart is often not markedly enlarged, and may be remarkably normal in appearance. Gross enlargement of the right auricle may occur in pulmonary stenosis so that the heart shadow may closely resemble that in Ebstein's syndrome. The important differential points are the pulsation of the right ventricle and dilatation of the pulmonary artery in pulmonary stenosis, as compared with the quiet heart and normal pulmonary artery in Ebstein's disease.

Angiocardiographically the cardinal feature of Ebstein's anomaly is a very large right auricle showing considerable delay in emptying. In some cases the atrioseptal communication is clearly visualized, also tricuspid notch may be seen to be displaced to the left.

There has been no report of successful surgical treatment in a proved case of Ebstein's anomaly.—*Harold Fulton, M.D.*

Plachta, Aaron, and Speer, Francis D. Eisenmenger's complex in association with congenital tricuspid endocarditis (fetal);

review of literature and report of case. *J. Pediat.*, March, 1953, *42*, 325–331.

The authors present a case of Eisenmenger's complex in a four month old male infant with congenital tricuspid endocarditis (fetal). The patient weighed 3 pounds and 4 ounces at birth.

The physical examination revealed an enlarged heart, diastolic murmurs at the apex and pulmonic areas, cyanosis, and a rapid, regular pulse of fair quality. Signs suggestive of pneumonitis and atelectasis were present in the right upper and lower lobes. The laboratory data revealed polycythemia. The chest roentgenogram showed focal bullous emphysema, atelectasis and pneumonitis in the right lung. The transverse diameter of the heart was increased.

Autopsy disclosed an enlarged heart with the deformities encountered in Eisenmenger's complex. Both ventricular walls were thickened. The edematous tricuspid valve measured 4.0 cm. The free border of the atrial surface was lined by a row of raised, translucent, pale gray attached vegetations, pin point in size, extending to the endocardium of the chordae tendinae. The firm tricuspid leaflet partly overhung the high interventricular septal defect. The interventricular septal defect measured 0.8 cm. The foramen ovale was patent. The lungs revealed edema, pneumonitis and congestion.

The term fetal endocarditis was introduced by Rokitansky who considered the lesion to be inflammatory accounting for the basic mechanism of cardiac anomalies. Keith believes the lesion to be of developmental origin, basing his conclusion on the concomitant anomalies he found in other parts of the body during fetal development.—*James F. Martin, M.D.*

Rushmer, Robert F., Crystal, Dean K., Tidwell, Robert A., Crose, R. F., and Hendron, John A. Complete transposition of the great vessels. *J. Pediat.*, Feb., 1953, *42*, 189–194.

The authors present 2 cases of complete transposition of the great vessels proved at autopsy. They feel that modern cardiac surgery offers in these cases the only hope for survival.

This particular type of defect can be accurately diagnosed on the basis of the following findings: (1) cyanosis which begins immediately after birth; (2) increased blood flow and blood content in the pulmonary vessels; (3) right ventricular preponderance; (4) progressive cardiac enlargement; (5) retardation of growth and development; (6) angiocardiographic evidence of continuity between the right ventricle and the aorta.

The authors state that excepting this condition cyanosis early in life is almost invariably associated with obstruction to the pulmonary blood flow and reduced lung markings as demonstrated roentgenologically. A roentgenogram of the heart taken two to five seconds following injection of diodrast into the antecubital vein should definitely provide the diagnosis of complete transposition of the aorta.

A short résumé of the embryology is given describing the formation of the congenital defect. The functional effects are discussed—namely, those of cyanosis and progressive cardiac enlargement which is principally right ventricular in type. It is apparent that survival depends upon continued patency of the communication between the two circuits, *e.g.*, defects in the interatrial or interventricular septum or a patent ductus arteriosus. The obvious decrease in oxygen to the peripheral circulation results in decreased growth and development.

The 2 cases are presented in detail. The first case showed progressive cardiac enlargement over a period of six months. The patient's condition improved remarkably for three days following a Blalock operation, then she suddenly developed cyanosis, dyspnea, liver enlargement and she died after twelve hours. A postmortem examination revealed a large thrombus of the left subclavian artery extending through the surgically induced anastomosis into the left pulmonary artery. The only congenital shunt was a small foramen ovale.

The second patient died suddenly thirty-six hours after an angiocardiographic study. No immediate cause of death was found. Postmortem examination showed three small interatrial septal defects about 3 to 4 mm. in size.—*Leslie L. Lemak, M.D.*

Abdomen

Porcher, P. Sur quelques perfectionnements techniques en radiologie digestive: tomographie des parois gastriques en double contraste gazeux. (Refined techniques in gastrointestinal roentgenology: tomography of the gastric walls using gas double contrast.) *Acta gastro-enterol. belg.*, Jan., 1953, *16*, 15–18.

When a suspected lesion cannot be demonstrated with conventional barium examination, a limited amount of gas (no more than 150 cc.) is introduced into the stomach, and a classical pneumoperitoneum is performed (600–1,000 cc.). The patient is slowly brought to the vertical position and frontal and profile roentgenograms are taken, after verifying with fluoroscopy that the gas has remained in the stomach. The patient is again placed horizontally, and laminagrams are made at 2 cm. distances starting at the posterior plane. The walls of the stomach are well outlined and slight changes in their thickness can be detected. Pillows placed under the shoulder or pelvis, bring the axis of the stomach in the same plane as that of the table, thus allowing full outline of the wall. If the lesion is at the cardia laminagraphy is best performed in the vertical position.

The diagnostic value of this procedure remains to

be proved, and its indications are to be more clearly defined. Theoretically, it offers the advantage over barium examination (which, at best, it should only supplement) of demonstrating wall thickness, whereas the latter will show only those lesions which disturb the mucosal pattern, and therefore will make possible the diagnosis of such lesions as linitis only at a late stage.—*Jonas Brachfeld, M.D.*

Meneghini, Carlo, and De Marchi, Renato. Il pneumoperitoneo nella diagnosi radiologica dei tumori cardiali e paracardiali. (Pneumoperitoneum in the roentgen diagnosis of cardial and paracardial tumors.) *Radiol. clin.*, March, 1953, *22*, 97–118.

The authors use a combination of pneumoperitoneum and barium meal for a more accurate visualization of the lesions of the cardiac end of the stomach and their relation to the surrounding structures.

The procedure consists of first introducing 1,000 to 1,500 cc. oxygen into the peritoneal cavity. Immediately after the completion of the gas injection, the patient is given to drink a semidense barium solution and is fluoroscoped in different positions. Roentgenograms are then taken in those views which best reflect the combined advantages of the two methods.

Seven cases are reported in detail to illustrate the various possibilities. The respective roentgenograms are reproduced together with diagrammatic sketches of the findings, all lesions having been verified at operation.

The authors draw the conclusion that the association of pneumoperitoneum with barium meal examination furnishes diagnostic data which cannot be obtained if either method is used alone. The procedure is of particular value in malignant tumors of the cardiac region of the stomach in that it permits evaluation of the extension of the lesion into the surrounding structures and establishment of the presence or absence of adhesions, especially between the stomach and diaphragm. Thus it aids considerably in assessing the criteria of operability in the individual case and in selecting the best approach for a certain type of operation.—*T. Leucutia, M.D.*

Laux, H., and Gombert, H. J. Über innere Fisteln der Verdauungswege. (On internal fistulas of the digestive tract.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1953, *78*, 153–159.

The actual demonstration of internal fistulas is possible only by means of the roentgen examination. There are definite sites of predilection for them.

Esophageal-bronchial fistulas are most frequently due to cancer, only rarely to inflammatory lesions. Fistulas originating in the stomach usually lead to the colon or the small intestine. Tracts between the stomach and the pleural cavity or the bronchial tree are rare. A carcinoma again is the leading cause. A special type of fistula is the one called gastro-jejunocolic fistula seen after gastric resection for an ulcer.

The fistulous tract can best be shown by contrast examination of the organ from which the perforation originates. Some fistulas lead into an abscess cavity and not into another organ.

Biliary fistulas are practically always due to gallstones. Such fistulas usually communicate with the duodenum. Duodenal fistulas of other etiology are very rare. Perforatioin of a duodenal ulcer into the urinary tract with air-filling of a kidney pelvis has been described.

Fistulas between loops of the small intestine are very difficult, if not impossible, to demonstrate. Diverticula of the intestinal tract may cause fistulas leading into a peritoneal abscess or may perforate into the urinary tract especially the bladder.

Several representative cases are discussed and illustrated by reproduction of roentgenograms.—*Hans W. Hefke, M.D.*

Moreton, Robert D. Roentgenologic considerations of gastro-intestinal lesions causing hematemesis. *South. M. J.*, Feb., 1953, *46*, 127–136.

The more common causes of hematemesis are discussed and illustrated by roentgenographic reproductions demonstrating these lesions.

Early examination is stressed. The cause of the bleeding can be demonstrated in approximately 85 per cent of the cases.

The author uses a small amount of barium for detailed mucosal study under the fluoroscope and at times double contrast to better demonstrate small lesions.—*V. L. Peterson, M.D.*

Canlas, Emilio M., and Fildes, Charles E. Radiopaque phytobezoar; case report. *Radiology*, Feb., 1953, *60*, 261–264.

The authors report a case of phytobezoar which had been rendered radiopaque by inorganic salts of calcium and bismuth. The presence of bismuth was attributed to ingestion of antacids with which the patient was treated for several years.—*A. R. Watson, M.D.*

Lichstein, Jacob, and Asher, Leonard M. Benign prolapse of gastric mucosa; clinical, roentgenologic, and gastroscopic study. *J.A.M.A.*, Feb. 28, 1953, *151*, 720–724.

The material studied comprised 52 patients seen in a period of more than three years in whom the primary diagnosis was prolapse of redundant gastric mucosa through the pylorus. Thirty-seven of these patients were gastroscoped and 7 were operated upon. The etiologic factors were considered to be the normal free movement of the gastrointestinal mucosa over the muscular layers, plus chronic inflammation and hypertrophy of the mucosa, or hypertrophy and

spasmodic contraction of the pylorus. Emotional stress was prominent in the history of these patients.

No clear cut clinical picture was found in all the patients. The "ball-valve syndrome" found in 31 per cent of the cases gave the most characteristic clinical history consisting of repeated attacks of localized epigastric pain of from forty-eight hours to days in duration associated with nausea and vomiting and not relieved by food. Hemorrhage occurred in 22 per cent of the patients, ranging from massive hematemesis to slight chronic oozing. Six of the patients were asymptomatic. The incidence of co-existing disease was high. Of 39 patients with a satisfactory history of symptom complaints, 35 had other gastrointestinal disturbances inclusive of gastritis, and 24 had associated disease of the esophagus, stomach, or gallbladder exclusive of gastritis. In additon, 51 per cent of the patients showed evidence of cardiovascular disease, and 29 per cent exhibited some psychiatric disturbance.

The diagnostic roentgenographic sign consisted of a defect confined exclusively to the base of the bulb, smooth in contour, lobulated and mushroom-shaped, with gastric rugae passing from the antrum into the bulb. The defect was changeable and disappeared at times. Gastroscopically, abnormalities were observed in the mucosa of all patients, with redundant mucosal folds in 40 per cent, hypertrophic gastritis in 35 per cent, and superficial gastritis in 20 per cent. In 25 per cent, the phenomenon of prolapsing mucosa was visualized during the gastroscopic examination. Differential diagnosis must include hypertrophic gastritis, pedunculated gastric polyp, prepyloric gastric carcinoma, duodenal ulcer, antral gastritis, neoplastic metastasis to the duodenum, retained food in the duodenal bulb, pylorus superimposed on the spine, and congenital bands, with prolapsing gastric polyp and either primary carcinoma or infiltrating carcinoma as the most confusing.

Medical treatment is similar to that for peptic ulcer. Indications for surgical intervention are intractability, pyloric obstruction, recurrent hemorrhages, and possible prepyloric malignant growth. In the 7 patients operated upon and followed for periods of one month to three years, 4 had good results and in 1 the result was undetermined.

The authors recognize the difficulty of proving unequivocally that prolapse is a definite clinical entity in view of the high incidence of associated gastrointestinal and gallbladder disease. They consider, however, that in certain instances it may in itself be productive of symptoms which will respond to appropriate treatment.—*Leslie K. Sycamore, M.D.*

Gants, Robert T., and Ryel, James W. Herniation of stomach and colon into omental bursa through a defect in the gastrohepatic ligament; report of a case. *Ann. Surg.*, Feb., 1953, *137*, 285–288.

This is a case report of a thirty year old white soldier with complaints of burning pain and sense of fullness in the upper abdomen after ingestion of large amounts of food or liquid. He had had bouts of distress at intervals following an automobile accident two and one-half years earlier. At that time he sustained a compound fracture of the right tibia and had crushed his chest and abdomen against the steering wheel. At the present admission, barium studies showed the transverse colon to be behind the liver on the right side. The stomach was placed transversely across the upper abdomen with the fundus beneath the left hemidiaphragm, the body extended across the midline and the antrum was behind the liver under the diaphragm.

At operation, a rent 5 cm. in length was found in the mid-portion of the gastrohepatic ligament. Through this rent had herniated the omentum, the transverse colon and the stomach which had rotated on its long axis so that the greater curvature was pulled up and over the lesser curvature. The omentum was adherent to the right lobe of the liver near the posterior layer of the coronary ligament. This caused a complete organo-axial volvulus of the stomach in addition to an obstructed transverse colon. It was impossible to free the omentum from its attachment to the liver until it was divided and sutured close to the inferior liver surface. Then the stomach, transverse colon and proximal stump of the omentum were readily reduced. There were no adhesions about the gastrohepatic ligament. There was apparently a laceration of the inferior surface of the right lobe of the liver which was plugged by the omentum thereby stopping hemorrhage and preventing herniation of the loop of small bowel.

The postoperative course was stormy, being accompanied by severe alkalosis and hypochloremia, but when these were corrected he began to improve. He also had a massive left lower lobe atelectasis which responded to aspiration and antibiotics. He was returned to duty seven weeks after operation and was symptom free.—*Robert K. Arbuckle. M.D.*

Neal, J. Walter. Traumatic right diaphragmatic hernia with evisceration of stomach, transverse colon and liver into the right thorax. *Ann. Surg.*, Feb., 1953, *137*, 281–284.

Traumatic right-sided diaphragmatic hernias are extremely rare. It is probable that the liver shields the diaphragm or that an injury so severe as to produce a rupture may cause death of the patient before repair can be instituted. A review of the American literature shows only 10 reported cases. In Harrington's series of 430 cases of diaphragmatic hernia treated surgically, he recorded only one hernia on the right side of traumatic origin.

A case report is made of a thirty-one year old colored male who was injured five years earlier. In addition to fractures of the pelvis and compound fractures of both bones of the legs he had an injury

to the abdomen, and roentgenograms showed free air beneath the right diaphragm and mottled density throughout the right lung. He recovered but continued to complain of fullness and distress in the right chest at intervals.

At the present admission there were altered physical findings on the right side. Roentgen examination revealed the heart displaced to the left and the right diaphragm was elevated to the fourth rib anteriorly and a collection of gas could be seen just beneath the diaphragm. Barium studies showed the ascending colon, hepatic flexure, and part of the transverse colon high up in the right chest. Barium by mouth showed the lower part of the esophagus and the stomach in the herniated mass.

At operation it was found that the liver, the ascending and transverse portions of the colon, and the stomach were in the lower right chest compressing the middle and lower lobes of the lung. A 20 cm. radial oval opening was present in the posterior medial leaf of the right diaphragm. All organs except the liver were readily returned to the abdomen and the opening was enlarged to permit return of the liver to the abdomen. The phrenic nerve was crushed and then by starting at each end of the diaphragmatic opening and suturing toward the center using figure of "8" sutures of No. 0 cotton the opening was closed. The exploratory incision was made through the right eighth rib and the author recommends the transthoracic approach for repair of such hernias. The postoperative course was uneventful and subsequent roentgen studies showed the abdominal viscera to be in normal position.—*Robert K. Arbuckle, M.D.*

Tolins, Stephen H. Congenital diaphragmatic hernia in the newborn. *Ann. Surg.*, Feb., 1953, *137*, 276–280.

The author reviews the literature and, to the 75 successfully operated cases in children under one year of age, adds another case. The day following birth, the baby showed a slight cyanosis and a markedly scaphoid abdomen. There was absence of breath sounds in the left chest with shift of the heart to the right. Roentgen studies showed loops of small bowel in the left chest. Following transfusions the child was operated on within twenty-two hours after birth and the stomach, spleen, entire small bowel, cecum, ascending and transverse colon and splenic flexure were in the left pleural space. There was a non-fusion along the posterior diaphragmatic attachment (foramen of Bochdalek). The organs were replaced and the diaphragm sutured alternately from each end toward the middle of the incision. After the atelectasis of the left lung was overcome by direct laryngoscopy and aspiration with catheter, the child did well.

One month after operation the roentgen examination showed normal lungs and good diaphragmatic contour and motion. Studies at nineteen months of age revealed no abnormalities. The phrenic nerve was not crushed. The operation was performed through an abdominal incision.—*Robert K. Arbuckle, M.D.*

Pearson, Seibert. Strangulated diaphragmatic hernia; report of four cases. *A.M.A. Arch. Surg.*, Feb., 1953, *66*, 155–166.

The author presents his experience with 4 cases and summarizes in outline form 27 cases of strangulated diaphragmatic hernia collected from the literture since 1948. He also presents a table showing the mortality in 74 recorded cases of this condition. Nonoperative mortality is 100 per cent, operative mortality 32.6 per cent. Strangulated diaphragmatic hernia should be considered as a possibility in any patient with lower thoracic or upper abdominal pain in whom the etiology has not been clearly established.

Case 1. A thirty-two year old woman, who developed intermittent cramping pain in the left upper abdomen and posterior chest seven hours after a normal delivery. A diagnosis of diaphragmatic hernia with probable strangulation was made after physical examination and roentgen studies and the patient was operated upon seven hours after onset of symptoms. Only the descending colon and spleen were found in the peritoneal cavity, the remainder of the gastrointestinal tract being in the left pleural cavity, with the diaphragmatic defect in the posterolateral portion (pleuroperitoneal hiatus). The gastric wall and greater omentum were edematous and hemorrhagic. After reduction of the herniated organs, the diaphragm and abdomen were closed and the patient made an uneventful recovery.

Case 2. A seventy-two year old woman, who twelve hours before admission developed sudden severe pain in the epigastrium, radiating to the right side of the chest and shoulder and accompanied by fainting. On admission she was dyspneic, complained of severe upper abdominal pain, appeared acutely ill and went into shock five hours later. Roentgen examination confirmed the diagnosis of right diaphragmatic hernia with intestinal obstruction. The white blood cell count was 19,750, with 91 per cent polymorphonuclears and 118 per cent hemoglobin. Several years previously the patient had sustained several fractured ribs on both sides in an atuomobile accident. At operation the defect in the diaphragm was posterior to the liver and the right pleural cavity contained a large quantity of dark bloody fluid and a loop of gangrenous ileum. The defect in the diaphragm was closed and 5 feet of gangrenous ileum resected, intestinal continuity being restored by a side-to-side anastomosis. The patient made a slow, steady recovery and has remained well.

Case 3. A fifty-four year old woman, who complained of nausea, vomiting and diarrhea following ingestion of sardines at lunch one and one-half hours earlier. She continued to have epigastric pain and occasional vomiting, and roentgen examination of

the chest and abdomen showed a large collection of gas and fluid in the lower half of the right chest, overlying but not displacing the heart. Operation, the day after admission, revealed the entire stomach within the posterior mediastinum except for 2 cm. of the pylorus. The entire gastric wall was black and the cardia extremely thin. A total gastrectomy was done and the hernia repaired. The patient died on the sixth postoperative day.

Case 4. An eighty-nine year old woman, who experienced sudden acute upper abdominal pain with radiation under the sternum three hours before admission. Examination revealed the cardia and fundus of the stomach above the diaphragm with volvulus of the distal portion of the stomach. Operation three hours after admission revealed a parahiatal hernia 6 cm. in diameter with the proximal portion of the stomach in the mediastinum. The serosa of the intra-abdominal portion was injected. The stomach was reduced, the hiatus closed snugly about the esophagus and the patient made an uneventful recovery.

The importance of early diagnosis and surgical intervention is emphasized.—*Arthur B. Smith, M.D.*

Phillips, J. H. C. Jejunal diverticulosis; some clinical aspects. *Brit. J. Surg.*, Jan., 1953, *40*, 350–354.

Diverticulosis of the jejunum, though frequently asymptomatic, can cause symptoms of chronic intestinal obstruction, as well as acute Abdominal complications. These diverticula are of the mucous membrane type. They are usually multiple and are concentrated in the proximal jejunum. They are situated along the mesenteric border of the intestine, apparently closely related to the point of penetration of the muscle coat by the mesenteric vessels. They are wide-mouthed and are not prone to stasis.

The author presents 3 cases, 2 of which appeared as chronic small intestine obstruction with clinical symptoms of pain, vomiting and loss of weight. At operation dilated segments of jejunum bearing multiple diverticula were found. No evidence of an organic obstructive lesion was present.

On roentgenological examination, several of the fluid levels may be present in the diverticula themselves, although this is difficult to diagnose preoperatively. The author believes that local dyskinesia with irregular peristalsis in a segment of the intestine may precede and be the causative factor for the formation of the diverticula. The obstruction is therefore neuromuscular in origin. Once the diverticula are present, they aggravate the condition since the intestinal contents are forced into them instead of along the intestinal tract.—*Lawrence A. Davis, M.D.*

Feldman, Maurice, and Myers, Philip. The diagnostic evaluation of erect positioning in cholecystography. *Radiology*, Feb., 1953, *60*, 222–225.

The upright position was incorporated in 105 consecutive cases of cholecystograms. This position permitted visualization of gallstones which were not demonstrable or clearly shown in the prone position in 3 cases. Floating type of gallstones were seen in 1 instance.

The following indications for erect cholecystography are presented: (1) when clinical evidence indicates the presence of gallstones and none are visible in the prone position; (2) to exclude the possibility of floating nonopaque gallstones; (3) to establish the presence of multiple minute granular positive or negative stones or sediment which, when separated, are not clearly demonstrable in the prone position; (4) to exclude overshadowing of bony structure, gas bubbles, or extrinsic calcified shadows; (5) to reveal stone shadows at the bottom of the visible gallbladder or a grouping of small shadows in the nonfilled vesicle.—*Everett E. Seedorf, M.D.*

Dunne, Edward F., Jensen, Esther H., and Hughes, C. Robert. Telepaque: a new medium for cholecystography. *Radiology*, Feb., 1953, *60*, 210–214.

The pharmacology of telepaque is briefly described. Side reactions including particularly nausea, vomiting, diarrhea and dysuria, are compared in two groups of patients receiving 4.5 gm. priodax and 3 gm. telepaque respectively. Approximately one-third as many patients experienced side effects with telepaque as with priodax. There was a pronounced decrease in the incidence of diarrhea and a higher incidence of dense gallbladder shadows observed with telepaque.

In a second series of cases the dose of telepaque was reduced to 2 gm. in patients under 160 pounds weight and 2.5 gm. in heavier patients. This resulted in further reduction of side effects and produced satisfactory visualization of the gallbladder with accuracy as great as when larger doses were employed.

Five tables recording the side effects and accuracy of gallbladder visualization are included.—*Everett E. Seedorf, M.D.*

Whitehouse, Walter M., and Martin, Owen. A comparative clinical study of priodax and telepaque, including 1,000 examinations. *Radiology*, Feb., 1953, *60*, 215–221.

The authors report a superiority of telepaque over priodax. Side effects were correlated on 500 patients who received priodax and on 400 patients who received telepaque. It was observed that 20 per cent more patients were asymptomatic as regards side effects with telepaque than with priodax when equal doses of the two compounds were used.

In comparing the degree of visualization of the gallbladder, a series of 1,000 examinations, 500 with

each medium, was chosen. Telepaque resulted in nearly three times as many excellent shadows as did priodax, and the number of cases with faint or no shadows was demonstrably less.

In a group of 151 cases examined with both telepaque and priodax, the use of telepaque resulted in more dense gallbladder shadows in over 65 per cent of the patients.

Because of the increased iodine content of telepaque a denser gallbladder shadow is produced and this affords better demonstration of radiolucent calculi. Although opaque calculi may rarely be obscured by the increased density of the opaque medium, these stones are visible on survey roentgenograms. Portions of the duct system are commonly demonstrated. The granular opaque residue in the colon did not interfere with proper gallbladder interpretation.

Three tables and three figures are included.—*Everett E. Seedorf, M.D.*

KIRKLIN, B. R., and O'DONNELL, D. BRENDAN. Present-day cholecystography. *J.A.M.A.*, Jan. 24, 1953, *151*, 261–263.

At the Mayo Clinic iodoalphionic acid (priodax) is used in preference to tetraiodophthalein. Six 0.5 gm. tablets are taken at 6 P.M. during or immediately after a meal of the usual quantity but not including any eggs, cream, butter or other fats.

The following morning three sets of roentgenograms are taken at two hour intervals. If gallstones are revealed on the first set, further roentgenography is deemed unnecessary. Utilizing a specially constructed motor driven table all patients are examined prone and in the right lateral decubitus position. The latter position has been helpful in displacing gas in the hepatic flexure of the colon from over the gallbladder.

A cholecystographic report of disordered function, gallstones or tumors should never alone be regarded as calling for an operation, for the finding may have no relation to the patient's symptoms, and final judgment as to treatment must be left to the clinician.—*James J. McCort, M.D.*

STEVENSON, CLYDE A. Roentgenologic examination of gallbladder without opacification. *J.A.M.A.*, Jan. 24, 1953, *151*, 264–265.

The plain roentgenogram of the gallbladder can yield information of value. Opaque areas can be localized in regard to their position in relation to the anterior or posterior portions of the abdomen and also whether or not they are in the gallbladder region. A primary gallbladder shadow always indicates gallbladder disease. With rare exceptions, gaseous shadows in the glalbladder or biliary duct system indicate a definite pathological process.—*James J. McCort, M.D.*

PIRKEY, EVERETT L., DAVIS, LAWRENCE A., and PILLA, LAWRENCE A. Peroperative and postoperative cholangiography. *J.A.M.A.*, Jan. 24, 1953, *151*, 266–268.

The authors' method of peroperative cholangiography consists of placing a cassette tunnel or portable Bucky diaphragm under the patient before the operative preparation and draping. The patient is then prepared in the usual manner for gallbladder surgery. After identifying the cystic duct, the surgeon makes a small incision in the duct, through which a ureteral catheter is inserted. A suture is tied about the cystic duct including the gallbladder to prevent backflow into the gallbladder. The anesthetist hyperventilates the patient to produce a period of apnea. About 20 cc. of an aqueous solution of ethyl iodophyenylundecylate (pantopaque) is injected through the catheter. An exposure is made as the last few cubic centimeters are injected.

A normal appearing duct system on the film is said to be ample evidence against the need of an exploration. If an abnormality is seen, however, an exploration is done in the usual manner.—*James J. McCort, M.D.*

DE L'ARBRE, GENEST. Multiple liver abscesses; report of a case successfully treated and followed with cholangiograms. *Ann. Surg.*, Jan., 1953, *137*, 135–137.

Liver abscesses are either amebic or pyogenic. The proportion of amebic abscesses has been reported as high as 74.7 per cent. Pyogenic abscesses may be solitary or multiple and the latter usually arise as a complication of a pre-existing suppurative process located most frequently in the appendix and, next in frequency, in the gallbladder. Multiple abscesses present as an acute disease of sudden onset with chills and fever, often of the "picket fence" type, followed by enlargement of the liver and jaundice as late and usually grave signs. The organism most frequently recovered from the cavities is *B. coli.* When the disease is secondary to biliary tract pathology, obstruction is always present.

In the reported case, the typical clinical picture was present and there was no response to intensive antibiotic therapy. A cholecystectomy and choledochotomy was performed confirming multiple abscesses and a T tube inserted in the common duct. A cholangiogram three weeks after operation demonstrated numerous abscess cavities and stones in the common duct. Intensive antibiotic therapy was again ineffective and re-exploration within five weeks resulted in removal of three stones from the common duct together with "gravel" from around the T tube. Subsequently the patient improved rapidly, and two weeks later cholangiograms revealed no abscesses.

The author considers the demonstration of the

abscesses by cholangiography to be significant and points out that improvement is not to be expected until adequate drainage is well established.—*C. N. Borman, M.D.*

Beeler, John W., and Beeler, Raymond C. Barium study of gastrointestinal tract in determining cause of jaundice. *J.A.M.A.*, Jan. 24, 1953, *151*, 268–270.

Lesions producing obstructive jaundice, particularly peri-ampullar malignant lesions, can frequently be discovered by means of barium examination of the stomach and duodenum. The finding of esophageal varices is not only helpful in confirming an already suspected diagnosis but may be the only evidence of an existing cirrhosis. Cholecystenteric fistulas can be accurately diagnosed by the radiologist.—*James J. McCort, M.D.*

Givner, D., and Chang, D. J. Problems in diagnosis and complications of amebic infection of the liver. *Am. J. Digest. Dis.*, Feb., 1953, *20*, 32–39.

Amebic hepatitis and amebic abscess are relatively uncommon in the United States. However, the authors report 5 cases of amebic infection of the liver treated in the Indianapolis Hospital. The correct diagnosis was suspected in only 1 case prior to hospital admission. Each case responded to specific therapy.

The importance of a complement fixation test early and of roentgenological examination of the chest with special reference to fixation of the right diaphragm due to irritation from liver pathology is stressed. Approximately three to seven years elapsed before hepatic involvement was recognized in 4 patients. In questionable cases a therapeutic test should be tried with emetine hydrochloride.—*V. L. Peterson, M.D.*

Renfer, H. R. Das Pneumoretroperitoneum durch präsakrale Insufflation. (Penumoretroperitoneum by presacral insufflation.) *Radiol. clin.*, Jan., 1953, *22*, 29–43.

After a brief historical review of pneumoperitoneum, the author refers to the more recent work of Ruiz Rivas who introduced generalized retroperitoneal emphysema for contrast study, now bearing the name of pneumoretroperitoneum (see this Journal, Nov., 1950, *64*, 723–734). The method consists of injecting gas into the presacral area; from here it diffuses upward through the deep areolar tissues which form an anatomical continuity from the sacral region to the neck. De Gennes has slightly modified Ruiz Rivas' technique by performing the injection in the midline and somewhat deeper caudally and by using an ordinary needle.

The author has used this new method in 28 cases. The subjective symptoms of the patients during the injection of the gas were similar to those encountered during the direct perirenal insufflation. There was a sensation of fullness in the mid-abdomen, then in the upper abdomen, and frequently there was radiating pain towards the mediastinum although no analgesics were required. One patient developed a slight cervical emphysema eight hours after the injection, and in 2 other patients the injection remained unsuccessful (due to extensive abdominal adhesions).

With the aim of reducing the discomfort and risk to the patient to a minimum, the author has introduced the following modifications of the original technique:

(1) The patient is prepared as for contrast examination of the gastrointestinal tract or intravenous urography. Preliminary fluoroscopic survey of the abdomen is advisable since even a partially filled stomach may produce resemblance to a subphrenic tumor in the roentgenogram.

(2) The injection of the gas is done with the aid of a lumbar puncture needle which is introduced into the precoccygeal area under the guidance of a finger placed in the rectum.

(3) The amount of gas, and the duration and pressure of injection are controlled by a special filling apparatus constructed, at the author's suggestion, by the Firma Schaerer AG., Bern. This apparatus is illustrated by a diagrammatic representation and a photograph. On an average, 1,500 cc. carbon dioxide is injected in approximately five minutes under a pressure of 80 to 150 mm. Hg at first and gradually increasing it to 250 mm. Hg toward the end of the injection.

(4) Attention is paid to the lumbar typmanism which toward the end of the injection must be quite pronounced.

(5) The author observed no drop in the systolic pressure, as reported in the literature following direct perirenal insufflation, but believes, nevertheless, that the blood pressure should be checked every two hours for six hours after the injection.

(6) Without changing the injection technique, turning of the patient from side to side helps more readily to fill the upper compartments of the abdomen.

(7) Fluoroscopic examination of the abdomen prior to roentgenography is recommended in every case, if possible, to gain a preliminary orientation of the anatomic distribution of the gas.

(8) The best roentgenograms are obtained during the first two hours after injection.

(9) The slow absorption of the carbon dioxide gas (lasting about three days) permits combination of the pneumoretroperitoneum with various other methods of examination, such as laminagraphy, intravenous or retrograde pyelography, barium filling of the stomach and duodenum, etc.

(10) To prevent the gas from ascending into the

mediastinum, all roentgen examinations are made with the patient in a horizontal position or by having his pelvis slightly elevated.

Eight of the 28 cases are presented in short resumes and their roentgenograms reproduced to illustrate various diagnostic possibilities.

The method is considered to be simple, perfectly safe and of definite clinical value.—*T. Leucutia, M.D.*

Crikelair, George F., and Hiratzka, Tomiharu. Intraperitoneal mercury granuloma. *Ann. Surg.*, Feb., 1953, *137*, 272–275.

Although the use of mercury in the passage of long tubes through the pylorus is frequent, complications following escape of the mercury from the tube are rare. A case is reported in a twelve year old Negro boy admitted with an acute abdomen of four days' duration who was thought to have a perforated appendix with an abscess forming. He was treated non-surgically. A film of the abdomen five days after admission showed mercury scattered throughout the bowel. An abscess was drained twelve days after admission and he was discharged with instructions to return for an appendectomy in three months. He remained asymptomatic and did not return until a year later when he had a sudden attack of pain, nausea and vomiting. At operation two hours after admission, loops of small bowel, cecum, appendix and dome of the urinary bladder were adherent to the anterior abdominal wall. A mass containing mercury was found attached to the structures in this area. The appendix was inflamed and had perforated near its tip.

Histologic sections showed granulation tissues surrounding globules of mercury. There were numerous secondary abscesses in the granulation tissue. Tiny globules of mercury were seen in the active foci of suppuration and were thought to be an integral part of the foreign body reaction.—*Robert K. Arbuckle, M.D.*

Freeb, E. Zur Differentialdiagnose des Dünndarm-Ileus. (The differential diagnosis of small intestinal ileus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1953, *78*, 141–152.

In cases of suspected small intestinal obstruction a survey roentgenogram of the abdomen is of great diagnostic importance.

Gas distention of intestinal loops and the demonstration of fluid levels on upright films are the most valuable signs. While gas is usually present in the colon, in adults it almost always indicates an abnormal condition when seen in the small intestine. A very small amount of gas in nondistended loops of the small intestine is occasionally seen when no ileus exists. A single dilated loop, sometimes with a fluid level, is, however, the first sign of small intestinal obstruction. When the colon is contracted and shows no gas or fluid levels and when at the same time there is a single small intestinal loop distended with gas, a mechanical obstruction is very likely. The important point is the absence of gas in the colon. In other cases of ileus (nonobstructive) as in enteritis, pancreatitis, intestinal gangrene, mesenteric thrombosis, etc., there is always some gas in the colon, usually even an increased amount. In small intestinal obstruction the increased peristalsis seems also to affect the colon causing empyting. It appears that gas and stools are passed for awhile after the obstruction has occurred. The gas dilatation of the small intestine takes place from two to four hours after the onset; therefore, the roentgen signs may be absent in the very early cases. Later a paralytic ileus may obscure the signs typical for small intestinal obstruction.

Ten illustrative cases with reproduced roentgenograms are presented.—*Hans W. Hefke, M.D.*

Burnham, Preston J. Acute bowel obstruction; forty years after blunt trauma. *A.M.A. Arch. Surg.*, Feb., 1953, *66*, 167–170.

Blunt traumas to the abdomen have resulted in injury to all the viscera, especially the spleen, liver, kidney, bowel, and diaphragm. Little has been written about delayed effects of the serious crushing injury for which no immediate operation has been performed.

Spellberg and Ochsner, in seeking a relationship between non-penetrating trauma to the small intestine and regional enteritis, traumatized the small intestine of dogs at laparotomy by crushing. Autopsy on survivors several months later revealed marked adhesion formation with large ropes of fibrous tissue and compression of the intestine.

Küttner reviewed the cases of remote sequelae to blunt injury to the intestine up to 1930. In 207 references to abdominal injury only 21 cases of secondary stricture of the intestine were found, 2 of the duodenum and 19 of the jejunum and ileum.

Schloffer's experiments showed that strictures may result from trauma to the intestinal wall or to the mesentery. In case of the former, the stricture may be due to submucosal or subserosal hemorrhage, chyloma, or herniation of the mucosa into a split of the muscularis. In case of the latter, a mesenteric hematoma may dissect into the wall of the intestine and cause fibrosis or vascular injury with ensuing fibrosis. Schloffer is quoted as stating that a true stricture following blunt trauma to the abdomen occurs only in the small intestine and has never been observed in the large intestine.

The author presents a case of a fifty-six year old man operated upon for intestinal obstruction, who was found to have obstruction of the upper ascending colon due to hard, thick bands of gray scar tissue extending from the ascending and transverse mesocolon to the lateral and posterior abdominal wall.

These bands were rather avascular and easily freed by sharp dissection.

No etiologic agent for the fibrous tissue could be found at operation. The patient later recalled that, forty years before, the rear wheel of a loaded wagon had gone over his abdomen. He suffered severe pain at the time, was kept in bed a week and for the next six months walked doubled in half because of the pain.—*Arthur B. Smith, M.D.*

Frech, Karl. Die Rektographie. (Rectography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Jan., 1953, *78*, 53–62.

A new method of roentgenological visualization of the rectum and lower end of the sigmoid by means of barium containing suppositories which cause uniform coating of the rectal wall with contrast material is described. The suppositories are composed of bismuth subgallate, thymol recristo, hexamethylenetetramine and aluminum acetotartrate and barium, and they produce a foam on contact with the rectal contents which causes uniform coating of the mucosa. A cleansing enema precedes the examination, then 1–3 suppositories of 0.5 to 2 gm. are used. The best visualization is obtained forty-five to ninety minutes after introduction of the suppositories.

Ten short case histories with roentgenographic reproductions are included, illustrating the usefulness of this method in cancer of the rectum. The method seems to be of particular value inconstricting tumors where the upper limit is inaccessible to the proctoscope and in cases with incontinence of the anal sphincter where an ordinary barium enema examination is difficult to perform.

The reproduced roentgenograms show a somewhat granular coating of the mucosa which does not appear to be as complete and continuous as the one obtained with an ordinary barium enema. The mucosal pattern is less distinct, but, on the other hand, minute filling defects and distortions of the lumen are well shown.—*Karol E. Matzinger, M.D.*

Genitourinary System

Peyton, Alton B. Bladder neck obstruction in the young male adult. *J. Urol.*, Jan., 1953, *69*, 109–117.

Bladder neck obstruction in 26 young men suffering from median bar and bladder neck contraction who were admitted to an Army and Navy General Hospital over a period of two years is discussed.

The symptomatology of this condition is neither constant nor pathognomonic. The predominant complaints were nocturia, diurnal frequency, dysuria and urgency. Hematuria was occasionally encountered and low back pain and low abdominal pain occurred in about 30 per cent of the cases. The duration of symptoms varied from childhood to within one year of hospitalization. Several of these patients had been treated previously for kidney disease and very few of them had had a complete urologic survery.

Physical examination usually revealed a prostate gland which was normal or smaller than normal. Prostatic secretions were infected in approximately 50 per cent of the cases. Urograms were helpful in confirming the clinical impression of bladder neck obstruction but did not help in determining the exact type of obstruction. Trabeculation and diverticula of the bladder were demonstrated as were dilatation of the lower ureters and hypertrophy of the interureteric ridge. Urethrograms were in some cases suggestive of the type of obstruction. Accurate diagnosis was made only through careful use of the cystoscope and panendoscope. Cystoscopy revealed a bar or dam across the inferior portion of the vesicourethral orifice with depression of the trigone proximally and of the prostatic urethra distal to it. The circumference of this orifice not occupied by the bar was usually contracted so that the outlet often consisted only of a pin-point opening. In this series the bar and contracture were almost always co-existent, and one was rarely found to exist without the other.

Treatment was both medical and surgical. Medical treatment was directed toward the eradication of all infections. Surgical treatment has been resection of the lesion, with transurethral resection the procedure of choice. Suprapubic removal, while not used in this series, has proved unsatisfactory in other similar cases. In the vast majority of instances the obstruction was not limited to one segment, and surgery had to be performed throughout the entire circumference of the orifice. At the completion of surgery the vesico-urethral orifice should be wide open, roughly circular, and the floor of the bladder and prostatic urethra should be virtually on the same plane with no intervening tissue.

The amount of tissue removed varied from 2 to 5 gm. The pathological diagnosis on tissue removed showed a predominance of benign hyperplasia and inflammation. Postoperative care should include bladder neck dilatation at monthly intervals for six months. Any infection must be carefully controlled.

The author reports 3 cases illustrating symptoms and surgical management of bladder neck obstruction. He stresses that symptoms of this condition are not pathognomonic and diagnosis can only be made through a thorough urologic investigation.—*George W. Chamberlin, M.D.*

Morris, Norman. Pregnancy complicated by congenital polycystic disease of the kidneys. *J. Obst. & Gynaec. Brit. Emp.*, Dec., 1952, *59*, 822–828.

Congenital polycystic disease of the kidneys is inherited as a Mendelian dominant. Pregnancy does

not affect the rate of cystic formation nor the ultimate prognosis of a patient except where severe pyelonephritis occurs, especially if this has required surgical exploration. The signs and symptoms are usually those of renal insufficiency complicated by acute pyelonephritis which may be the initial complication which presents itself in pregnancy.

Case 1: Primigravida, aged twenty-seven, who was known to have polycystic disease. She developed an increase in blood pressure, and cesarean section was done at 8½ months, a healthy male infant being delivered weighing 7 lb. 9 oz. Follow-up demonstrated no abnormality.

Case 2: Primigravida, aged twenty-eight (sister to Case 1). She first became pregnant in 1946 and recurrent attacks of pyelitis responded to sulfonamides. She delivered normal twins. Blood pressure remained normal. Investigation of the urinary tract following delivery demonstrated bilateral polycystic disease. She again became pregnant in 1951 and aborted at fourteen to sixteen weeks. She now has mild hypertension.

Case 3: Primigravida, aged twenty-nine, pregnancy terminated at eight weeks by hysterotomy on 11-19-37 because of infection and severe pain in the right side. On 1-15-38 exploratory of the right kidney was done and a large amount of pus evacuated from a cyst. She was seen again on 1-15-40, eight weeks pregnant, vomiting and with pain in the right side. On 3-1-40 hysterectomy and sterilization were done. She was again seen in December, 1943, with left-sided pyelonephritis and the left kidney was explored and a large amount of pus evacuated. In September, 1945, she was explored for a right-sided pyelonephritis and much pus evacuated. Following this she had a stormy course with blood urea level of 200 to 300 mg. per cent, and a high blood pressure of 160–200/100–105. Prognosis is poor.

Case 4: Primigravida, aged seventeen, being in the twentieth week of her pregnancy, was first seen in the antenatal clinic on 12-13-50 because of hypertension and albuminuria. She was previously examined in 1948 and suspected to have right hydronephrosis. She was admitted to the hospital on 12-16-50 with a blood pressure of 150/90 and a heavy cloud of albumen in the urine. Despite medical treatment the renal damage progressed, as evidenced by an increasing amount of albumen in the urine and a steady rise in the blood urea. Therefore, on 1-22-51 the pregnancy was terminated by abdominal hysterectomy, sterilization being performed at the same time. At operation, the right kidney appeared normal but the left kidney was considerably enlarged by several cysts of varying size. The patient made an uneventful recovery; however, re-examination in August, 1951, still showed a blood pressure of 150/100 and there was a large amount of albumen in the urine.

Case 5: A fifty-six year old white female was seen in 1945 with hematuria. She had two children, aged thirty-two and thirty-three. Investigation of the case revealed bilateral polycystic disease.

Case 6: A fifty-six year old white female was seen in 1945 with vaginal prolapse and a mass in the left kidney area. The left kidney was removed and pathological examination demonstrated polycystic disease. She had seven full-term normal deliveries and two miscarriages. The last full-term pregnancy was eighteen years before.

Polycystic disease is not a contraindication to pregnancy; however, the known case of polycystic disease who becomes pregnant should be closely observed and infections of the urinary tract should be treated promptly and vigorously. Increasing blood pressure or blood urea levels or other signs of renal failure may require termination of the pregnancy.—*Neal F. Yeomans, M.D.*

Allen, G., and Orchard, N. P. Renal agenesis. *J. Obst. & Gynaec. Brit. Emp.*, Dec., 1952, *59*, 810–813.

The ante mortem diagnosis of bilateral renal agenesis is of no value to the patient apart from prognosis, although it may assist the pathologist in his post-mortem approach. Congenital absence of the cartilage of the ears resulting in "flop ears" or "elephant ears" should lead one to suspect the diagnosis of bilateral renal agenesis. Two cases are presented, one of which had "flop ears" and the other showed no gross abnormality. There was nothing in the case history of either case to suggest the cause of the abnormality. The first infant lived four hours and the other lived one hour and twenty-five minutes.

The etiology of this condition is unknown and there is much discussion concerning possible etiological factors. The authors conclude that Amolsch's "blighting factor" with retardation and perhaps regression, whether due to virus infection in early pregnancy or other causes is more acceptable than the mechanics of oligohydramnios and adhesions.

A total of 163 cases of congenital absence of both kidneys have been reported since 1663 (Leffler, 1951). These two cases bring the total to 165 cases. The authors are of the opinion that many cases go unrecognized and that the incidence is much higher than this.—*Neal F. Yeomans, M.D.*

Wellens, P., and Persyn, M. A propos de deux cas d'ostéodystrophie rénale. (Two cases of renal rickets.) *J. belge de radiol.*, 1952, *35*, 603–616.

Various factors account for the great variations in the roentgenologic appearance of the skeleton seen in these cases: age at which renal difficulties start, nature and degree of renal insufficiency, and the presence of hyperparathyroidism and other metabolic or endocrine derangements.

The consensus, is that the main pathogenic cause is acidosis, which leads to disturbance in calcium

absorption in the intestine. Hyperparathyroidism occurs later as a result of phosphatemia and hypocalcemia. Detectable changes of the osseous system are formed by the combination of four factors: generalized osteoporosis, reactive osteosclerosis, retardation of ossification and retardation of osteoid growth.

In about half the cases there is generalized osteoporosis with a large-meshed trabecular appearance. Sometimes this is less obvious because of concomitant reactive osteosclerosis which results in ground-glass appearance. Osteoporosis is always particularly manifested in the hands. In 3–5 per cent of cases cysts result from the pronounced osseous destruction. The calvarium is thickened and the tables of the skull are not well outlined. The vertebrae may be deformed and flattened or, again, may appear more or less dense. Pseudofractures may be seen in the usual sites. The lamina dura disappears as in all advanced cases of osteoporosis. Various other deformities may be noted. The metaphysis is enlarged and appears mottled. The diaphyso-epiphyseal line is frayed but the epiphyseal nucleus is normal and clearly outlined, whereas in rickets it is smaller and its borders appear eroded. Subperiosteal erosion, an important sign that can be detected even when there is little diffuse decalcification, should be looked for in all cases of suspected renal rickets. Sites of predilection are the phalanges of the fingers, the internal border of the proximal end of the tibia, the distal end of the ulna and the distal end of the clavicle. In the phalanges of the middle and ring fingers this erosion, forming a lace-like picture, is most characteristic. It is said to occur only in primary or secondary hyperparathyroidism.

Growth is not impaired in rickets and no dwarfing occurs in that disease, because the formation of osteoid ground substance continues and only its calcification is defective. In renal rickets, on the other hand, formation of osteoid is markedly retarded. Epiphyseal growth zones are therefore larger in rickets than in renal rickets.

Nephrocalcinosis is rare in renal rickets except in cases with primary lesions in the tubules. It is more common in primary hyperparathyroidism or in cases where calcium is deposited in scarred renal tissue after glomerulonephritis or tuberculosis. Renal stones, well known in primary hyperparathyroidism, may also be present in secondary hyperparathyroidism. Calcium deposits in the lungs, heart, stomach, blood vessels and periarticular tissues have been reported in only 1 per cent of cases. The heart may show a congenital lesion, part of the total picture, or insufficiency secondary to the renal lesion.—*Jonas Brachfeld, M.D.*

Rosina, G., and Galdini, S. L'antrace del rene; contributo alla diagnosi e alla terapia. (Carbuncle of the kidney; contribution to its diagnosis and therapy.) *Arch. ital. urol.*, 1953, *26*, 47–62.

The incidence of carbuncle of the kidney has not been high, and with the present widespread use of the antibiotics in all forms of infection, the incidence is decreasing due to the control of the renal metastases and the arrest of the process in the early stages.

The initial signs and symptoms of a renal carbuncle can be very scanty: urinary symptoms may be absent, the urine examination is negative, the kidney function is normal and the roentgen findings are within normal limits.

Renal carbuncle may be missed in the presence of a perinephritic abscess which is often incised and drained without exploring and treating the parenchymal focus. It is this type which, after surgical intervention, presents a protracted septic course without any tendency to improve.

The authors present 7 case histories. In the diagnosis, emphasis is placed on the symptom of sudden sharp flank pain which they believe indicates a perforation of the capsule of the kidney. The urine examination was generally negative and they doubt whether bacteriological study of the urine could facilitate the diagnosis. The presence of a leukocytosis is an important factor in the decision to intervene. In all their cases kidney function was normal. The roentgen examination almost always gave definite information. The preliminary roentgenograms, including inspiration and expiration roentgenograms, may reveal the findings of a perirenal abscess. The characteristic signs of a carbuncle on intravenous or retrograde pyelography are a filling defect or amputation of one or more calyces and a deviation or modification of the outline of the calyces, and less frequently of the pelvis of the kidney. These findings are difficult to differentiate from those of a neoplasm. In the presence of a clinical course indicative of acute infection, the diagnosis is apparent. However, when the suppurative process has undergone encapsulation or become "encysted" with few or no signs of infection, differentiation becomes impossible.

As an additional sign, the authors have noted spasticity of a group of calyces of the cortical zone of the kidney involved, indicative of local irritation. In one case there was a collection of the opaque medium beneath the capsule at the site of the abscess or carbuncle. It was further noted in 3 cases that during the retrograde study the injection of a few cubic centimeters of the opaque medium produced a severe pain.

The treatment of carbuncle of the kidney is both medical and surgical. It is possible to bring about a cure with penicillin alone in the early stages. Surgery is indicated where the capsule has been perforated with the formation of a perirenal or a perinephritic abscess and when the subcapsular lesion has become encysted—the latter result having occurred much more rarely before the use of antibiotics.—*Lucien M. Pascucci, M.D.*

DEMING, CLYDE L. Renal neoplasms: an enigma and a challenge. *J. Urol.*, Jan., 1953, *69*, 1–9.

The literature of renal neoplasm has been difficult to evaluate primarily because of confusing classifications. Three simple facts concerning renal neoplasms have been apparent: (1) that they are highly malignant, (2) that the only treatment is surgical, and (3) that the results amount to 20 per cent controls over a five year period. Viruses, sex hormones, and cholesterol have produced renal carcinomas in certain laboratory animals.

The author proposes a new and simple classification of renal tumors:

1. Nephroma (Wilms')
2. Hypernephroma (adrenal origin)
3. Carcinoma of the cortex
   a. Embryonic
   b. Adult
   c. Scirrhous—pelvis
4. Papillary
   a. Pelvis
   b. Cortex
5. Neurogenic
   a. Neuroblastoma
   b. Ganglioneuroma
   c. Medulloblastoma
   d. Schwannoma
   e. Sympathicoblastoma
   f. Paraganglioma
6. Sarcoma

The components of the kidney from which these tumors may arise are the capsule, the system of epithelial tubules, the pelvis lined by transitional epithelium, and the pedicle containing blood vessels and various amounts of mesothelial and nerve tissue.

Nephroma (Wilms' tumor) occurs most commonly in children and has been found in newborns and fetuses. It contains all elements of the kidney and belongs in the embryonic group of tumors. It metastasizes by direct extension or by the blood stream. Its growth is rapid and it has a high degree of malignancy.

Hypernephroma occurs most commonly in adults in the sixth decade. It is the most common renal tumor in pregnant women, suggesting hormonal activation. It is the only neoplasm reportedly found in polycystic kidneys. It arises from congenitally misplaced suprarenal tissue and can occur anywhere in the kidney as well as in other intra-abdominal sites. The tumor may reach large size before metastasizing, although occasionally the metastatic lesion is larger than its original tumor.

Neuroblastomas and medulloblastomas are the most embryonic; ganglioneuromas and paragangliomas are more adult types. The schwannomas are similar in behavior to those at other sites. The more embryonic of these tumors are often seen in children. The difference in metastatic spread between the right and left located tumor is due primarily to their venous and lymphatic spread and not due to histopathologic differences. The neurogenic tumors frequently lie in close proximity to the renal pelvis producing roentgen evidence of deformity and obstruction.

Sarcomas may arise from the hilus within the kidney or from the capsule. They are usually invasive within the kidney and may invade the perirenal structures. Roentgenograms often show spotty areas of radiolucency indicating fatty tissue.

Carcinoma occurs at all ages, the embryonic type being seen more often in children. The adult type generally has its origin in adenomas. The embryonic type metastasizes early via the blood stream; the adult type may be slow growing and may erode into the pelvis producing hematuria as its first symptom.

Papillary carcinoma is similar to the transitional cell papilloma of the bladder. These carcinomas may arise in the cortex or renal pelvis, and their behavior from either site of origin is similar. There is a question as to whether the cortical papillary carcinoma arises from embryonic rests of the pelvis which are located within the cortex. One outstanding characteristic of these tumors is their metastasis to the ureter and to the bladder.

Treatment of Renal Neoplasms. Irradiation has been employed as a last straw in treatment of large tumors and has been used in the treatment of nephroma, hypernephroma, embryonic carcinoma and sarcoma. Irradiation will reduce the size of the responsive tumors, but there is no proof that it will produce complete control of tumor growth. It should not be employed until a microscopic study has been made to determine tumor type. Surgical treatment by nephrectomy has always been and still is the treatment for malignant disease of the kidneys, provided the growth can be removed. There are several surgical approaches: (1) the loin incision, (2) the transthoracic approach, (3) the dorsolumbar approach, and (4) the transabdominal approach, which is frequently used in children.

Results. The author does not use five or ten year survival figures. From a series of 132 renal tumors proved by biopsy, control of the tumor had been achieved in 9 per cent. By "control" the author apparently means survival for fifteen to twenty years without recurrence or autopsy which reveals no evidence of tumor. Unfortunately, immediate treatment for malignancy detected early or even accidentally has not resulted in better survival figures when compared with cases in which procrastination and late treatment was present. The author mentions treatment of renal malignancy by radioactive isotopes (the isotope diiodofluorescein) in conjunction with nephrectomy.—*George W. Chamberlin, M.D.*

HIGGINS, CHARLES C. Tumors of the renal pelvis; review of forty-seven cases. *Ann. Surg.*, Feb., 1953, *137*, 195–204.

Tumors of the renal pelvis are relatively rare con-

stituting 5–10 per cent of all kidney tumors. The papillary growth is more frequent.

The author reviews the literature and his own 47 cases. No five year cures are reported. Radiation therapy did not improve results. Surgical procedure of choice is nephro-ureterectomy with segmental resection of the bladder.—*Joseph Levitin, M.D.*

HARADA, AKIRA; OZAWA, SHIZU; TSUJI, TOMOMI; and INOUE, TAKEO. Several problems of urolithiasis. (Outline of our research during the past two years). *Yokohama M. Bull.*, Aug., 1952, *3*, 208–223.

Recurrence of urinary stone after conservative operation is observed in approximately 16.7 per cent of the cases. Most relapses occur within the first two years and thenceforth seldom. Unless urinary calculi are cured early, changes in the kidney may eventually become an irreversible state called "malignant stone-former." The ratio of recurrence in the mate kidney after conservative treatment is not greater than 4 per cent.

The pH of the urine plays an important role in urolithiasis. The authors dissolved a stone of a patient in hydrochloric acid and then neutralized this solution with ammonia. As long as the pH of the solution remained less than 5.2 there was no precipitation. At 6.4 marked precipitation was present. This was also true in the clinical course of the patient.

Many experiments have been carried out to study the relationship between vitamin A deficiency and urinary calculi. With improvement of dark adaptation, the excretion of urinary calculi is reduced.

Urolithiasis is common in patients during long periods of recumbency. Hirose (1941) found urinary stones frequently among patients of spinal transection, fracture of pelvis or lower extremities and injury of urethra or bladder. Of the patients with spinal lesions, 43.5 per cent had urinary calculi demonstrated clinically and 73.1 per cent at autopsy. The authors examined 50 recumbents and found 2 cases of urinary calculi accompanying myelitis. Ten persons, or 20 per cent, had increased calcium output in the urine. Periodic changes of position by turning, rotating and tilting will eliminate any particles of sediment which tend to accumulate in dependent places.

Certain substances, insoluble in water, are easily dissolved in a watery solution in the presence of some neutral salts such as sodium benzoate, sodium hippurate, sodium salicylate, and others. Such salts are called hydrotrophic substances.

Using bone-ash and hydrotrophic substances, the authors have worked out an equation to determine the calcium precipitability. They showed that ammonium citrate has a particularly strong effect.

The authors examined the citrate content of 8 urinary calculi and found 0–1.0 per cent citric acid. The urinary citrate content of 4 cases suffering from renal calculi was examined. In 1 case the citrate output was markedly decreased. In another, no change was present. In the other 2, urinary citrate content from the diseased kidney was distinctly diminished.

In order to clarify the relationship between renal function and metabolism of citric acid, the authors investigated the fluctuation of urinary citrate content in rabbits after the injection of mercuric chloride and simultaneous oral administration of calcium carbonate. Citrate was excreted in high concentration even if there was serious renal damage.

Administration of oxamide or sulfonamide to rabbits caused a remarkable decrease in urinary citric acid.

Clinical and experimental observations on the acid and alkaline phosphatase in renal calculi were also carried out. It was found that there was no direct correlation between alkaline phosphatase and stone formation and that acid phosphatase played a special role in the tissue independently of alkaline phosphatase.

The significance of the calcium deposit (calcium plaque) in the renal papillae as regards renal stone formation was also investigated by the authors. They examined the calcium plaques of 97 kidneys obtained by operation or necropsy. The kidneys of the necropsy cases were normal as these patients died suddenly. They found calcium plaques in 41 per cent of the cases. They feel that more importance should be attached to alteration in the tubules than to calcium deposition in the renal papillae.—*C. Peter Truog, M.D.*

JACOBS, ARTHUR, and STIRLING, W. BARR. The late results of ureterocolic anastomosis. *Brit. J. Urol.*, Dec., 1952, *24*, 259–316.

The authors present an analysis of a total of 1,673 cases of ureterocolic anastomosis collected from 137 members of the British Association of Urological Surgeons. Of this total there were 353 deaths, giving a mortality rate of 21.1 per cent.

A comparison is made between the direct and indirect methods of implantation. In direct anastomosis there was a much greater possibility of reflux of fecal contaminated urine into the upper urinary tract, indicated by spontaneous pneumopyelograms and regurgitation of radiopaque medium instilled into the bowel. They felt, however, that there was no clinical evidence showing that such patients experienced any greater untoward effect from such reflux. On the other hand, postoperative dilatation was greater in the indirectly implanted cases. Stenosis of the anastomosed ureter followed less frequently after the direct method of Nesbit. Judging from postoperative intravenous urography, the conclusion was that an oblique insertion through the wall of the bowel is much more likely to be followed by hydroureter and hydronephrosis than the direct methods.

The authors do not select any single method of anastomosis as the optimum one. The direct method of anastomosis seemed particularly applicable to dilated ureters produced by tuberculous urinary bladder disease. This was because of immediate unobstructed drainage at the anastomotic site.

Nine hundred and eighty patients (58.6 per cent) had no postoperative complications. The fewest complications were encountered in anastomoses done for tuberculosis, probably due to the fact that in almost every case a transplant was unilateral and cystectomy was not performed. Ileus occurred in 6.8 per cent, peritonitis in 3.6 per cent, urinary fistula in 6 per cent, abdominal dehiscence in 2.5 per cent. The usual cause of peritonitis was not contamination at the time of operation, but leakage at the site of anastomosis. Fistulas were due to local infection or to interference with the vascular supply, hematoma formation in the bowel wall, or continued gaseous distention. Other complications were grouped together and consisted of pelvic abscess, intestinal obstruction, pyleonephritis, bronchopneumonia and many other less frequent conditions.

Blood electrolyte changes were studied in 201 of the patients. Following transplantation there was an elevation of the blood urea level in the majority of patients lasting six months or more after operation. A state of acidosis was observed in an overall group of 78.1 per cent, the percentage rising after six months postoperatively. Hyperchloremia existed in almost one-half of the cases. This, too, increased during the first six month period. An elevated sodium blood level, however, dropped with increased postoperative time, and potassium levels were lowered in approximately 35 per cent. They conclude that there is no major abnormality at any time for sodium or potassium, but that urea, alkali reserve, and chloride undergo a more or less progressive rise as time passes.

The main symptoms of electrolyte imbalance were fatigue and weakness, anorexia, nausea and vomiting, salty taste in the mouth, thirst and ingestion of copious fluids, loss of weight, increased susceptibility to cold, rectal urgency and polyuria with diarrhea. The etiology of this syndrome is not known, but chloride absorption and renal damage acting in conjunction appear to be the major factors.

A detailed appendix is presented with this survey along with well correlated tables and charts.—*Robert L. Raphael, M.D.*

Chung, R. C. H., and Mantell, L. K. Urographic changes in diabetes insipidus. *J.A.M.A.*, Nov. 29, 1952, *150*, 1307–1308.

This is the case report of a twenty-five year old Japanese male with a history of classical diabetes insipidus since the age of three, admitted to the hospital because of a right tuberculous pleural effusion. While hospitalized his urinary output varied from 12 to 18 liters daily with a specific gravity of 1.000 to 1.005. Skull roentgenograms were negative.

Urologic investigation disclosed bilateral symmetrical dilatation of the calyces, infundibula, renal pelves and ureters. The urinary bladder was atonic and was capable of retaining 1,000 cc. of contrast medium and its dome reached the iliac crest.

Endoscopy revealed no obstruction of the vesical neck or urethra; the ureteral orifices were normal. In excess of 130 drops per minute, clear urine dripped from either ureteral catheter.

The urinary tract dilatation was explained on the basis of functional incompetence of outflow capacity of the urinary tract due to an abnormally high production rate of urine.—*I. R. Berger, M.D.*

Brockhaus, J. Subkutane Pyelographie bei jungen Kindern mit Hilfe der Hyaluronidase und mit Anwendung des Tomographen. (Subcutaneous pyelography in young children with the aid of hyaluronidase and laminagraphy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Nov., 1952, *77*, 602–605.

Because of slow excretion of the contrast material in subcutaneous pyelography, hyaluronidase has been used for faster absorption. In 20 young children such pyelograms were diagnostic in 16 instances. In the other 4 the examination was unsatisfactory owing to a very large amount of gas in the intestinal tract. For that reason laminagraphy was added, which usually allows a satisfactory demonstration of the urinary tract even when a large amount of gas is present. Films were taken forty minutes after the subcutaneous injection with hyaluronidase. Raising the upper part of the body about 7 cm. above the level of the pelvis allows the kidneys and ureters to be roentgenographed at approximately the same laminagraphic level. Occasionally the pelvis of a kidney can be better shown when the patient is rotated 45 degrees.—*Hans W. Hefke, M.D.*

Gottlieb, Charles, Beranbaum, Samuel L., and Hamilton, Richard H. Radiographic features of ureterocele. *Radiology*, Jan., 1953, *60*, 64–67.

A ureterocele is generally considered to be due to a congenital stenosis of the ureteral orifice with resultant ballooning and invagination of the terminal ureter into the bladder. This obstruction often causes hydronephrosis. A double kidney and ureter is often associated with a ureterocele and if such is the case, the ureter draining the upper kidney is the one usually involved.

The smooth, round, constant filling defect seen in the region of the ureteral orifice in the cystogram is diagnostic. On occasion, at the time of intravenous urography, the ureterocele wall may be seen as a

nonopaque halo of "cobra-head," the contrast substance being present in both the ureterocele and the bladder.

Five cases are presented, 2 of which occurred in adults.—*Martin B. Goodwin, M.D.*

Huggins, Charles. Endocrine factors in cancer. *J. Urol.*, Dec., 1952, *68*, 875–884.

This is the Guiteras lecture of June, 1952, given at the meeting of the American Urological Association. The author calls attention to much experimental evidence indicating that certain hormones, by their action on target cells at some distance, will produce cancer. These target cells may be in themselves synthetic factories of hormone production or they may be in tissues which do not in themselves produce hormones. The latter are referred to as end-organ targets and occur in the breast and prostate. A certain analogy can be drawn between pituitary-gonadal relationship and a closed-cycle feedback electrical circuit, in that the hormone which is produced by the target cells inhibits the hypophyseal action. In those instances where the feedback of hormone into the prime mover is interfered with, the result is an abnormal stimulation for growth in the target organ. Much experimental evidence is cited to indicate that in animals estrogen may produce mammary carcinoma, lymphoid tumors, uterine myoma and tumors of the kidney and testis. Excessive pituitary gonadotrophin production leads to carcinoma in the ovary when the feedback mechanism is inhibited. Radiation therapy over the ovaries of mice inhibits such a feedback mechanism and regularly leads to ovarian tumors in the animals.

The mechanisms available for the control of hormone dependent cancers are the removal of the source, or the vitiation of their physiological effects. The latter may be accomplished by inhibition through the use of competitive hormones. It has been shown that cancer of the male breast regresses after the excision of the testis and that cancer of the female breast regresses after excision of the ovaries. Likewise, treatment of certain prostatic carcinomas with estrogens and of certain mammary carcinomas with androgens, has been shown to be of clinical value in the palliation of these patients.

Certain mammary and prostatic tumors have been found to be dependent upon adrenal function. With the advent of cortisone and ACTH substitution therapy, bilateral adrenalectomy has been carried out in some of these patients without a fatality. The results of this operation are still to be completely evaluated. Bilateral adrenalectomy has produced amelioration of the malignant process in certain patients who have widespread carcinoma metastasis. Adrenalectomy has had no beneficial effect in patients with squamous carcinoma, melanosarcoma, chorionic epithelioma of the testis, cancer of the lung and cancer of the stomach. Those cancers which have responded have been primary in the breast and prostate.—*George W. Chamberlin, M.D.*

Loizzi, Angelo. La deferento-epididimografia. (Deferens-epididymography.) *Arch. ital. urol.* 1953, *26*, 63–73.

The author injected an opaque medium containing 30 per cent iodine into the spermatic duct of dogs, but found that this concentration of iodine was not satisfactory. With a concentration of 75 per cent, visualization of the duct and epididymis was adequate. Having satisfied himself that this procedure was innocuous and that it produced no abnormal changes in the duct and in the epididymis, he utilized it in 20 patients.

The technique is as follows: A 2–5 cm. long incision is made at the level of the external inguinal ring. After identifying the cord, the vas deferens is isolated and the lumen entered as in a venipuncture; 1 cc. of an opaque medium with an iodine concentration of 75 per cent is injected.

The following conditions were studied: hydrocele (10 cases); tuberculous epididymitis (5 cases); gonorrheal epididymitis (1 case); gonorrheal traumatic epididymitis (1 case); epididymitis secondary to parotitis (1 case); spermatocele (post-traumatic) (1 case); neoplasm (1 case).

The author concludes that visualization of the vas deferens and epididymis by an opaque medium can be a useful procedure, and because of its harmlessness, merits its being employed in those instances in which the diagnosis of the nature and site of the pathology is uncertain and in doubt.—*Lucien M. Pascucci, M.D.*

Middlemiss, J. H. Radiology in diseases of the prostate. *J. Faculty of Radiologists*, Oct., 1952, *4*, 115–124.

Advances in chemotherapy, hormone therapy, and surgery have so revolutionized the outlook in diseases of the prostate that they are fast coming to be regarded almost as minor incidents in the life of the aging male. The place of roentgenology in treatment of such conditions is here discussed.

Roentgenography is a most useful tool in deciding treatment as well as in diagnosing prostatic lesions. This includes plain roentgenography, excretion urography, and cysto-urethrography. There is no point in the surgeon skillfully removing the prostate and leaving a hypernephroma. The radiologist must give the "all-clear" to the upper urinary tract, and be prepared to sound the warning bell about other pathology in the lower urinary tract.

Many pathological as well as postoperative conditions can be demonstrated. Prostatic calculi, prostatitis, adenomatous enlargement of the prostate, prostatic carcinoma, post-prostatectomy conditions and complications all come within the realm of the diagnostic radiologist. While there is no way of diagnosing

prostatic carcinoma by excretion urography, there is one sign in cysto-urethrography which should be known. In the normal case and in adenomatous enlargement the prostatic urethra dilates during micturition. In carcinoma of the prostate, the posterior urethra is held rigid by the growth and does not dilate.

Prostatic enlargement will sooner or later affect the remainder of the urinary tract, depending upon the degree of obstruction and the length of time that it has existed. Bladder function is affected, in that the power to empty the bladder becomes impaired and emptying is incomplete. The bladder wall and its contents are affected by prostatic enlargement in that hypertrophy, trabeculation, diverticulum formation, dilatation and distention of the bladder, and calculi develop. There is progressive stasis of urine in and dilatation of the whole upper urinary tract, depending upon the degree and duration of prostatic obstruction.

Roentgenological methods and cystoscopy should be regarded as complementary to each other, both having their own part to play in investigation and treatment.—*Samuel G. Henderson, M.D.*

Miller, Ashton. Radiology in diseases of the prostate. *J. Faculty of Radiologists*, Oct., 1952, *4*, 125–129.

The author discusses the part played by roentgenology in benign prostatic hypertrophy and carcinoma of the prostate, from the viewpoint of the clinical urologist.

Intravenous urography enables one to detect early and less obvious changes, whereas clinical examination reveals only the gross abnormality. Renal anatomy is graphically portrayed. The intravenous urogram gives a good visual record of improvement following drainage and is more reliable than the determination of the blood-urea level as a clinical guide. Stasis in the lower ends of the ureters or persistent filling of the whole length of both ureters in the presence of good excretion usually goes with a considerable amount of residual bladder urine, and is a warning of impending renal failure. Bladder anatomy is depicted roentgenographically where it may be unwise to perform cystoscopy. Moreover, it is impossible to assess the size of a diverticulum with the cystoscope. Bladder function and determination of the amount of residual bladder urine may be obtained roentgenologically where the presence of a very large prostate contraindicates the passage of either a cystoscope or a catheter.—*Samuel G. Henderson, M.D.*

Valentino, A., and Mazza, A. Un segno radiologico dell'adenoma prostatico: peculiare alterazione del tratto terminal dell'uretere. Sue modificazioni dopo adenomectomia. (A roentgen sign of prostatic adenoma: peculiar alteration of the terminal ureteral tract; its modifications following adenectomy.) *Arch. ital. urol.*, 1953, *26*, 74–90.

The authors were interested in the study of the "fishhook" appearance of the terminal portion of the ureters in prostatic adenoma, particularly as to its cause and reversibility. The technique employed consisted of introducing oxygen by means of a catheter into the bladder after it was emptied following standard intravenous urography. After the abdominal compression on the ureters was removed, roentgenograms were made in the anterior projection with the patient supine and the central ray directed perpendicularly two fingers above the pubis, and in some cases in the oblique projection. By means of this method they were able to demonstrate the "fishhook" deformity of the lower ureters with the concavity directed cephalad.

In a group of unselected patients this alteration was found mostly in those cases in which the prostatic growth was predominantly subvesical or mixed in location, that is, subvesical and endovesical, with displacement of the bladder neck and trigone.

The "fishhook" appearance can be interpreted as resulting from this upward or anterior displacement of the bladder neck and trigone by the large prostate, without neglecting other important factors among which is emphasized the hypertrophy of the muscle bundles of the wall of the ureter, and a hypertrophy of the detrusor muscle.

The mechanical factor is not entirely responsible for this abnormality since the deformity did not disappear soon after the surgical removal of the large prostate. Only months later did the roentgenograms demonstrate a reversible trend, *i.e.*, a straightening and sometimes an inverted appearance of the terminal ureter with concavity directed caudad, a fact which the authors interpreted as being due to anatomical-functional factors.

The demonstration of this "fishhook" appearance, the authors believe, aids in differentiating roentgenologically between a prostatic mass which is enlarged within the bladder and one which is extravesical. This sign is of particular significance in lacunar defects at the base of the bladder, the interpretation of which as to endovesical or extravesical origin can remain uncertain even if the filling defect shows a convexity directed cranially. A mass developing extravesically will give the "fishhook" appearance. The authors also feel that the above deformity is the first sign of disease of the upper urinary tract resulting from a large prostate and constitutes a warning to undertake surgical intervention while the alteration of the ureter is still reversible.—*Lucien M. Pascucci*, M.D.

Harrison, J. Hartwell, Thorn, George W., and Jenkins, Dalton. Total adrenalectomy for reactivated carcinoma of the

prostate. *New England J. Med.*, Jan. 15, 1953, *248*, 86–92.

Subsequent reactivation of cancer of the prostate after inhibition by hormonal therapy has been a consistent and challenging aspect of the course of the disease. Following the logical assumption that androgens are an activating factor in the growth of prostatic cancer, Huggins and Scott attempted the further elimination of androgens by total adrenalectomy. Some clinical improvement was observed after this procedure during several months' survival but this was limited because of inadequate substitution therapy at that time (1945). Recently, the availability of cortisone has made survival possible in the absence of the adrenal glands.

This is a study of the early clinical course of 7 patients subjected to total adrenalectomy for cancer of the prostate. All the patients selected were suffering from reactivated carcinoma with recurrent regional and metastatic disease in spite of previous orchiectomy and continuous estrogen therapy for six months to five years. In 5 of these patients the pain was completely relieved soon after the adrenalectomy. The improvement persisted after the cortisone dosage had been reduced to maintenance levels. The patients gained strength and mobility and were able to perform physical activity without discomfort. Regression of pelvic masses with improvement of micturition has resulted in 3 patients and healing of osseous lesions in the spine has been demonstrated in 1, five months after adrenalectomy done four years after orchiectomy and the institution of estrogen therapy.

The mechanism of the sudden relief of pain after total adrenalectomy has not been explained. A profound alteration of metabolic processes that undoubtedly follows total adrenalectomy deserves further physiological investigation.

The important details of the case histories of the 7 patients are included.—*E. A. Addington, M.D.*

Nervous System

Malis, Leonard, Newman, Charles M., and Wolf, Bernard S. Full-column technic in lumbar disk myelography. *Radiology*, Jan., 1953, *60*, 18–28.

The use of small quantities, *i.e.* 3 cc., of pantopaque for myelography makes it difficult to obtain diagnostic films of disc protrusions owing to the normal irregularity of the anterior wall of the spinal canal. In addition, a small quantity of pantopaque often has insufficient depth to show the disc protrusion in profile when the patient is placed in the oblique position.

The authors have overcome these difficulties by placing the patient in the erect position by means of a tilt table and using sufficient pantopaque to reach above the level of interest. Then, with fluoroscopic control, posteroanterior, lateral and oblique roentgenograms are taken and the diagnosis is made from the films. The amount of pantopaque required varies with the size of the canal. In one case, 6 cc. brought the superior margin of the pantopaque to the level of the body of L-3 while in another, 12 cc. was required to bring the upper margin to the upper border of L-5. An immediate check of the films is made and if these are satisfactory, the pantopaque is removed. Since the pantopaque is almost entirely removed, the authors believe there is no contraindication to the use of these large quantities. They also state that any defect is reproducible on subsequent examination.

Many examples of disc protrusions demonstrated by this method are shown.—*Martin B. Goodwin, M.D.*

Shipp, Frank L. Technique and value of myelography. *J.A.M.A.*, Jan., 17, 1953, *151* 185–188.

Over 3,000 myelograms have been performed at the Lahey Clinic since 1938. The contrast medium in current use is pantopaque.®

The author advises myelography (1) to confirm or exclude an intraspinal lesion when other methods have failed to establish an unequivocal diagnosis, (2) to differentiate intervertebral disc protrusions from spinal cord tumors, to disclose multiple lesions, if present, and to localize any lesions thus found, (3) to investigate persistent or recurrent symptoms referred to the spine in patients who have undergone previous surgery, (4) to exclude tumors or similar lesions in patients with a presumptive diagnosis of degenerative disease of the spinal cord, and (5) to exclude intraspinal disease in patients about to undergo a spine fusion, with or without laminectomy, particularly in cases of spondylolysis or spondylolisthesis.

He advises against myelography in obvious malingerers, in the emotionally unstable, and in the very young and very old.

He recommends adequate preoperative roentgen examination of the spine and preoperative cleansing of the lower bowel with enemas only, He performs the puncture with the patient in the prone position with a folded blanket under the abdomen to minimize lordosis. That the needle may not slip out of the dural canal and that the nerve roots may not be injured, the patient is not allowed to change position after the puncture has been performed, but the blanket is removed. If the tap is bloody, the needle is withdrawn and inserted at another level. If the second tap is bloody also, the examination is postponed to avoid an uncertain study, difficulty in removing the opaque oil, possible leakage of fluid and oil, and possible epidural or subdural hemorrhage.

The author warns against overreliance upon fluoroscopy and recommends numerous spot roent-

genograms. In cases of suspected tumor, the entire length of the spinal subarachnoid space is inspected, and in cases of suspected disc protrusion, fluoroscopy is carried at least as high as the eighth dorsal segment.

For removing the oil, gentle intermittent aspiration with a 2 cc. syringe is advised to avoid nerve root damage.

Headache is less apt to occur if the patient is kept flat for twenty-four hours. It is less severe if fluids are restricted for twenty-four to forty-eight hours. When persistent, epidural injections of 25 to 50 cc. of sterile isotonic sodium chloride solution may be given as often as needed.—*George Cooper, Jr., M.D.*

Martínez, Guido Torres, and Olivera, Vicente García. "Epidurograma." (Epidurography.) *Radiología*, Panamá, Dec., 1952, *3*, 21–22.

The authors have undertaken a study of the caudal and the epidural routes for roentgenologic contrast injection which will be reported in full at a later date. This is a preliminary communication regarding 5 cases to establish priority for extradural exploration of the spinal canal by means of contrast introduced through the sacral hiatus. The authors have not found prior reference to this method in the literature.

The method, which they hope will be called "epidurography," seems very interesting and important in those affections for which myelography is indicated. It differs somewhat from the results obtained by the subdural route, but is more extensive and more complete, affording information regarding medullary, meningeal, radicular, meniscal, and skeletal pathology, some of which is not afforded by the usual myelogram. Farr in 1932, in the only report found regarding extradural exploration with contrast agents, determined in the cadaver that injected substances visualized the entire length of the spine from the caudal region to the sixth cervical vertebra.

For the injection the patient is placed in ventral decubitus with a sandbag under the pubic region. Local anesthetic is first injected (metycaine 1.5 per cent solution), making sure that the end of the needle does not enter any important vessel and that no spinal fluid escapes, as this is not desired. The quantity of opaque material employed (pantopaque) varied from 9 to 15 cc. Full details as to technique are given in the article.—*James T. Case, M.D.*

Phillips, Ralph. Neuroblastoma; Hunterian Lecture delivered at the Royal College of Surgeons of England. *Ann. Roy. Coll. Surgeons England*, Jan., 1953, *12*, 29–48.

Cancer occupies third place as the cause of death in children under fifteen years of age. After accidents and pneumonia, cancer causes more deaths in this age group than poliomyelitis, measles and diphtheria combined. Neuroblastoma next to leukemia is probably the commonest type of cancer in children and the author feels it is necessary to dispel the persisting idea that it is incurable. His material consists of 81 cases of neuroblastoma from the Memorial Hospital from 1932 to 1951 and a review of the literature.

Primary neuroblastoma is most frequently found in the adrenal glands. The second most frequent site is the retroperitoneal space (other than the adrenals) and the third site is the posterior mediastinum. Other and less frequent primary sites are the orbit, the neck and the skin. Neuroblastoma is locally invasive, and therefore its complete surgical removal is not, as a rule, possible. Ganglioneuroblastoma is often encapsulated and may be completely excised. Both metastasize to the lymph nodes, liver and the bones. About three-fourths of the cases in the author's series showed bone metastases at the time of admission to the hospital. The impression that tumors of the right adrenal, as originally described by Pepper, metastasize to the liver and abdominal lymph nodes and that tumors of the left adrenal, as described by Hutchison, metastasize to the skeleton has probably been refuted by Poore's analysis of 389 cases. The most frequent symptoms that may lead to an early diagnosis are attacks of abdominal pain, the discovery of a swelling, febrile attacks and locomotor disturbances. Symptoms such as bone pain, limp, enlarged lymph nodes, proptosis, ecchymosis of the eyelids and loss of vision are indicative of metastatic invasion. The chief means of definitive diagnosis are roentgen examination, aspiration biopsy, sternal marrow aspiration and surgical exploration. Survey films of the abdomen usually show a tumor in the retroperitoneal or posterior mediastinal regions. Areas of calcification which may be finely mottled and multiple, but are more frequently dense and single, are often observed. Excretory pyelography generally shows displacement of the kidney downward and laterally. The renal calyces are not, as a rule, deformed as in Wilms' tumor. Bone metastases are usually osteolytic and symmetrically distributed in the long bones.

It is the author's opinion that treatment is not hopeless, but that it must be aggressive, and an attempt should be made to initiate a regression and perhaps induce a change from a neuroblastoma to a benign ganglioneuroma. Long term remissions or cures have been recorded following biopsy or partial removal, ionizing radiations, Coley's toxins, nitrogen mustards, antifolics and cortisone. Cases showing spontaneous regression have been reported and the author cites such a case in a four month old infant with a large left adrenal tumor with diffuse lymph node and liver metastases who in spite of roentgen irradiation and chemotherapy developed in rapid succession bilateral proptosis, profound anemia and subcutaneous and cranial metastases. At the age of

one year, a striking remission occurred and at the age of three she is reasonably well. The average duration of the disease in the 65 fatal cases in this series was eleven months. Of 58 cases at the Memorial Hospital between 1932–1949, 48 survived for less than three years. One died six years after onset and 9 are still living for three years or more, and 6 of these 9 survived for six years or more, giving a 17 per cent three year survival rate.

The presentation includes a detailed description of the pathology, natural history, symptoms and signs, definitive diagnosis, treatments and results, with tables, photographs and roentgenographic reproductions, and is a scholarly and valuable contribution to the literature.—*W. W. Maver, M.D.*

Oberhill, H. R., Smith, Roger A., and Bucy, Paul C. Neoplasms of central nervous system simulating degenerative disease of spinal cord. *J.A.M.A.*, Feb. 21, 1953, *151*, 612–619.

In this interesting paper the authors present 5 well documented cases illustrating the various patterns of space-occupying neoplasms of the central nervous system which can simulate degenerative diseases of the spinal cord. Two of these cases were originally confused with multiple sclerosis, one with amyotrophic lateral sclerosis, and two with subacute combined degeneration of the spinal cord. They point out that the common reasons for confusing degenerative diseases and compression of the spinal cord are: (1) withholding myelography because there is no evidence of subarachnoid block on Queckenstedt's test; (2) failing to realize that a myelogram may not reveal a midline herniation of a ruptured disc or an intraspinal tumor; (3) considering essential the presence of pain and sensory symptoms for the diagnosis of intraspinal tumor.

The authors emphasized that in these cases early diagnosis is important so that the patient's condition will not continue to deteriorate under the impression of a hopeless degenerative disease. For this reason, exploratory laminectomy must be seriously considered in every suspected case of compression of the spinal cord.

In reviewing these cases it is demonstrated that although routine roentgenograms of the skull and spine may appear negative, examination in special views may reveal the diagnosis. The most valuable roentgen findings are widening of the spinal canal and erosion of the vertebral pedicles. The age of the patient is helpful in the differential diagnosis in that degenerative diseases tend to fall in certain age groups, *i.e.*, multiple sclerosis is predominantly observed in young adults while amyotrophic lateral sclerosis is principally a disease of older people. Valuable clues are gained from the laboratory studies as the protein level of the spinal fluid or the absence of free hydrochloric acid in the stomach often leads to a clear cut diagnosis in these problem cases.—*T. D. Allison, M.D.*

Skeletal System

Terrafranca, Raymond J., and Zellis, Allan. A case of congenital rickets. *Radiology*, Feb., 1953, *60*, 192–197.

A case of congenital rickets in a premature infant is reported. Classical roentgenographic signs of rickets were found in the long bones, ribs, phalanges and metatarsal and metacarpal bones when the infant was three days old. Response to therapy was good, with almost complete disappearance of rachitic changes by the time the infant was ten months old.

Reports of congenital rickets are not numerous. From the authors' discussion of the literature it would appear that only about 20 cases have been reported. Most of the reported cases appeared to be due to osteomalacia or malnutrition in the mother.—*Arno W. Sommer, M.D.*

Guck, John K., and Wolf, Julius. Monarticular and destructive arthropathy in Reiter's syndrome. *Am. J. M. Sc.*, Dec., 1952, *224*, 653–658.

The occurrence of polyarthritis accompanied by urethritis and conjunctivitis is generally accepted under the name of Reiter's disease or syndrome. The exclusion of gonorrheal infection as the causative agent is essential to the diagnosis.

The usual sequence of events is an initial urethritis with mucopurulent discharge accompanied by frequency, dysuria, and on occasion hematuria. Conjunctivitis follows, which is usually purulent. In a significant number of cases this finding has been absent. The outstanding symptom, and the one for which the patient is hospitalized, is arthritis. Almost any joint may be involved, but there is a definite predilection for the weight-bearing joints. The disease is usually found in the adult male.

Most of the usual therapies for this condition have been tried without success. In most cases, the disease is self-limited, and supportive measures with proper physical therapeutic procedures seem to be the best form of treatment.

In the past five years the authors have observed 7 cases of the disease, 2 of which presented features not usually described.

The first patient was a twenty-six year old male with swelling of the right ankle, conjunctivitis, and urethral discharge. All joints were normal except the right ankle which was swollen, red, and warm. Roentgenograms of this joint were normal. The patient was treated symptomatically and discharged in a month cured.

The second case was that of a thirty-six year old male. For a period of five years this patient had been treated intermittently for urethral discharge, conjunctivitis, and pain in his ankles and left wrist. Pain, swelling, and stiffness of the left wrist had been a persistent finding during the entire course of his

disease. Roentgenograms of the left wrist revealed early destructive arthritis. Both ankles were normal. The patient was treated with dihydro-streptomycin, 1.5 gm. daily, for seventy-two days. The symptoms subsided on this regimen and ultimately bony ankylosis of the wrist occurred.

These 2 cases represent variants from the usual description of this disease. One was solely monarticular and the other was predominantly monarticular-and led to joint distortion.—*William C. MacCarty, Jr., M.D.*

Ray, Edward S., and Fisher, Hugh P., Jr. Hypertrophic osteoarthropathy in pulmonary malignancies. *Ann. Int. Med.*, Feb., 1953, *38*, 239–246.

Hypertrophic osteoarthropathy has been discussed more frequently in the recent literature. The list of diseases which have been said to cause this condition is now becoming quite long. The pathologic process is essentially one of proliferative subperiosteal osteitis, surrounding the shaft of the long bones.

The authors discuss the relationship between clubbing of the fingers and osteoarthropathy but draw no definite conclusions. They carefully studied 139 cases of carcinoma of the lung to determine whether there was any relationship between osteoarthropathy and type and location of the pulmonary lesion. They found 14 cases of osteoarthropathy associated with malignant disease of the lung. In 13 of the cases, the tumor was located in the periphery of the lung. They state that the size and type of the tumor has nothing to do with the development of osteoarthropathy.—*R. E. Kinzer, M.D.*

Barba, William P., II, and Freriks, Dick J. The familial occurrence of infantile cortical hyperostosis in utero. *J. Pediat.*, Feb., 1953. *42*, 141–150.

The authors present 2 cases of infantile cortical hyperostosis in utero—the cases being those of siblings.

A preliminary review of the disease is given indicating that the onset may occur during the last months in utero and the first seven months of life. The disease is characterized by the development of brawny, tender, non-hyperemic, non-suppurative swelling over one or more bones followed by the development of underlying cortical hyperostosis. The bone changes persist up to twelve months after the soft tissue swelling has disappeared. Remissions and exacerbations are frequent but after the first year of life lesions are rarely observed. The bone changes are described as affecting the diaphysis of the long bones without involving the epiphysis or metaphysis. Laboratory findings may sometimes show fever, elevation of the sedimentation rate and of the serum alkaline phosphatase, anemia and mild leukocytosis.

The first case showed classical findings. The bone changes were demonstrated roentgenographically one week prior to delivery. The majority of the long bones showed the cortical thickening. The alteration persisted for over seventeen months. The disease caused a delay in standing and walking. The only treatment given was well-baby care. The only residual was slight anterior bowing of both tibiae.

The second case was the brother of the first and showed only changes in the right leg with an associated pseudoparesis. This baby was treated with ACTH at a dosage adequate to reduce the eosinophil cell count to near zero for one week. The tenderness of the extremity disappeared in forty-eight hours. There was a definite decrease in the swelling within one week. The only ill effect of the treatment was an inability to gain weight during its course. Normal weight gains appeared forty-eight hours after ACTH was discontinued.

The following factors are considered in discussing the etiology of the disease: (1) Infection (Caffey), although there is little support for this. No inflammatory reaction in bone, periosteum or soft tissue has been demonstrated. (2) Excessive embryonal osteogenesis (Mossberger). The authors note that the lesions of the disease have been recorded in a variety of sites which approximate the locations of the primary centers of ossification. Since primary ossification consists of more or less simultaneous development of enchondral and perichondral bone formation, the authors postulate that an avascularity is produced by the rapid development and in some instances subsequent distortion of the fetal bones. This results in a failure of normal perichondral bone formation. The enchondral bone increases compensatorily. This, with the factors of rapid growth, preliminary ossification, muscle pull and change in anatomical relationship, results in the bone changes as demonstrated roentgenologically. The changes in the soft tissues, consisting of atrophy and fibrosis, can also be explained by avascularity. The pain and tenderness observed clinically may be due to periosteal stretching by the mass of aberrant cancellous bone or secondary to atrophic changes due to avascularity. (3) A familial factor is introduced by various reports of occurrences of more than one case in a family, including the authors' 2 cases. (4) Endocrine factors. The fact that the lesions occur in fetal life and rarely after seven months of age would support this theory; however, all known hormones affecting bone growth exert their greatest influence at the epiphysis or metaphysics and these findings are not seen in this syndrome. The response to ACTH requires more investigation before an endocrine factor is ruled out. A word of caution in the use of ACTH is sounded since at this early age it may result in profound electrolyte disturbances and increased risk of infection.

The authors postulate in conclusion that there is a defect in vascular supply to the diaphysis occurring in the third fetal month of life and resulting in embryonal osteodysgenesis.

Roentgenographic reproductions clearly illustrating the changes described are included.—*Leslie L. Lemak, M.D.*

Morgan, Paul W. Osteochondritis dissecans of the supratrochlear septum. *Radiology*, Feb., 1953, *60*, 241–243.

The supratrochlear spetum of the humerus, separating the coronoid and olecranon fossae, is occasionally the site of osteochondritis dissecans. This appears to be a true aseptic necrosis. It is seen as a radiolucent defect in the distal humerus bordered by a bony ring and containing irregular sclerotic fragments which may become displaced anteriorly and posteriorly into the elbow joint space. Pain and limitation of motion occur, often necessitating removal of fragments.—*William A. Goodrich, Jr., M.D.*

Green, William T. and Banks, Henry H. Osteochondritis dissecans in children. *J. Bone & Joint Surg.*, Jan., 1953, *35-A*, 26–47.

This paper is the report of a study of 27 cases of osteochondritis dissecans, all of which occurred in children under the age of fifteen years; in 19, the treatment was by nonoperative means. Most of the patients had a presenting symptom of intermittent joint disability of mild degree. In those who had chronic intermittent symptoms referable to the knee, a variable history of recurrent pain was the rule. Soreness, stiffness, particularly on first movements, giving way, clicking and occasional swelling, which was interpreted as joint effusion, were some of the other more common complaints.

Physical signs were not specific at the time of examination in the majority of those patients in whom the symptoms were intermittent and of long duration. Atrophy of the controlling muscles was the most common abnormal finding. Local tenderness was present in about one-third of the cases. Limp, excess fluid and limited motion were common findings in the small number who had relatively severe symptoms. In one-half of the patients, no physical findings suggesting abnormalities were recorded at the time of examination.

Osteochondritis dissecans in children presents a crater-like area of rarefaction in roentgenograms which involves the articular subchondral bone, just as in adults. In more than half of the cases, these crater-like lesions contained fragments resembling loose bodies or sequestra. In 75 per cent of the knees, the medial femoral condyle was involved in its lateral portion, with the process often extending to the margin of the intercondylar fossa adjacent to the posterior cruciate ligament. The most common location in the anteroposterior plane, as seen in lateral roentgenograms, was just posterior to a line which is made by bisecting the shaft of the femur and the epiphyseal plate. The lesion not infrequently was posterior to this position but rarely was it anterior to it.

Posteroanterior tunnel views should be a part of the routine roentgenographic examination. This tunnel view is particularly valuable in visualizing the posterior portions of the condyles and the intercondylar notch. The most satisfactory tunnel view is obtained by placing the patient prone, flexing the knee to 60 degrees, and then tilting the tube in a caudad direction so that the rays pass through the joint at an angle of between 20 and 40 degrees, depending upon how far posteriorly in the condyle one wants to emphasize the visualization. The posterior portion is best seen in the more angular projection, the usual angle being 20 to 30 degrees. Anterior tangential views, so-called tangential patellar views, are considered helpful by the authors in visualizing lesions in the anterior portion of the condyle and in the patella. Off-lateral views and oblique projections may be of assistance in visualizing each condyle separately.

The authors' experience suggests first, that osteochondritis dissecans is not uncommon in children, and second, that, when the lesion is protected, the process can heal quite promptly. This can occur even in the patients in whom there is apparent sequestral formation within the confines of the cavity of the osteochondritic lesion. The histological evidence in the cases of the patients who came to operation tends to confirm the idea that the basic process in osteochrondritis dissecans is an aseptic necrosis involving subchondral bone and that all other changes are secondary. If the joint is protected so that the cartilage does not become broken, the dead bone can be invaded, absorbed, and the lesion can heal by "creeping substitution." Thus protection seems to be the treatment of choice in children, provided there is no loose body in the joint and provided the clinical manifestations subside promptly. In the majority of instances surgical intervention is not indicated.

The etiology of osteochondritis dissecans remains in doubt. Trauma is usually given first consideration as a causative factor either through direct injury or indirectly by interruption of the vascular supply of the subchondral bone. The authors suggest there is some further underlying factor which makes the individual particularly susceptible to osteochondritis dissecans and to osteochondritis in general.—*R. S. Bromer, M.D.*

Walk, L. Diagnostic lumbar disk puncture; clinical review and analysis of sixty-seven cases. *A.M.A. Arch. Surg.*, Feb., 1953, *66*, 232–243.

The author presents a clinical review and analysis of 67 cases, with 98 disks examined. The original

method of lumbar disk puncture as introduced by Lindblom has been modified to eliminate fluoroscopic observation. With the patient in a prone position and with pads under the abdomen to reduce the lordosis, a metal centimeter scale is fixed above the vertebral column and a lateral film, with horizontal rays is exposed. On the film the introduction of the needle through the skin is calculated and the depth to the nucleus pulposus is measured. The straight way to the disk is just below the vertebral arch. A double needle is employed. After the inner needle has been introduced into the nucleus a mixture of 2 cc. of 35 per cent diodrast and 0.5 cc. of 50 per cent procaine hydrochloride is used as the contrast medium. The amount injected varies between 0.5 and 2 cc. and slight pressure may be applied on injection. If high pressure is needed this indicates the needle is in an incorrect position in the fibrous annulus and has to be corrected. In a normal disk there is greater resistance than in a degenerated one. The presence and distribution of pain on injection is noted. Exposures are made in frontal, oblique and lateral positions.

The material is analyzed as to roentgen findings on disk puncture, plain roentgenography and myelography and as to the clinical findings and the findings on operation. It is divided into four groups: (A) normal disks; (B) disks without or with only slight deformity of the nucleus pulposus but with a posterior or lateral rupture and a spread of the contrast material; (C) degenerated disks with a broad cavity instead of the oval nucleus pulposus; and (D) degenerated disks, as in group C, but with a posterior or lateral rupture and a spread of the contrast material.

A. *Normal Disks.* Five cases with five disks were examined, 4 between the 5th lumbar and 1st sacral, 1 between the 4th and 5th lumbar. Puncture revealed an oval nucleus pulposus; the roentgenogram of the spine showed a normal disk interspace; and myelography demonstrated a normal appearance except for slight posterior bulging of the disk between the 4th and 5th lumbar vertebrae.

B. *Disk Rupture with only Slight Deformity of Nucleus Pulposus.* There were 15 cases with 25 disks examined: 3—5th lumbar-1st sacral, 9—4th-5th lumbar, and 3—3rd-4th lumbar disks. The rupture usually had the appearance of a narrow channel from which the contrast material was spreading to the epidural space to form a local accumulation, sometimes containing particles of tissue, or spreading diffusely to a varying extent. The nucleus pulposus was only slightly irregular. The ordinary roentgenogram was normal in half of all cases and changes, if present, were generally slight. Myelography has frequently revealed slight cases (slightly increased posterior bulging in 2 cases and irregular or thickened nerve roots in 6 cases). A prolapse was found in only 1 case.

Clinical findings revealed that two-thirds of the cases had pain on coughing and all showed a positive Lasègue sign. The Pandy and Nonne tests were frequently positive. A 4th-5th lumbar disk was most frequent in this group. Age range was between thirty-nine and forty-nine years. Symptoms and signs appeared to be caused by two factors—compression of the nerve and perineural infiltration by the escaped contents of the nucleus pulposus. This parallels the two kinds of pathologic-anatomic change, degeneration fibrosis and arachnoidal proliferations around the nerve roots, as described in the literature. In group B irritation due to perineural spread appeared to be the major factor.

Operation on 4 cases of this group revealed a prolapse in 1 case, thickened nerve roots in 2 cases and negative findings in a 4th case.

C. *Degenerated Disks.* There were 26 cases, with 36 disks examined: 15 were 5th lumbar-1st sacral, 9 were 4th-5th lumbar, and 2 were 3rd-4th lumbar. There was a broad contrast-filled space, instead of a normal nucleus, frequently extending over the whole interspace. There was no rupture or spread of the contrast material. The roentgenogram was usually pathologic, with normal findings in only 5 cases. In the other cases, hyperostoses and slight to marked narrowing of the interspace were found. The myelogram showed disk prolapse in 7 cases, slight deformities, chiefly of nerve roots, in 12 cases, and normal findings in 4. In 3 cases myelography was not done.

Clinically, a 5th lumbar-1st sacral disk was most common in this group. Numbness, a positive Lasègue sign and an abnormal Achilles reflex were the most frequent findings.

Of 7 cases operated upon, 3 had prolapsed disks, 1 hypertrophied ligamentum flavum and 3 were negative. Myelograms done on 6 of these 7 cases before operation were positive in 3, 2 showing prolapsed disks and 1, slight bulging of the disk without prolapse. Of the 3 cases in which myelography showed only slight deformity one prolapsed disk was found, with a negative exploration in the other 2 cases.

D. *Rupture of Degenerated Disk.* There were 21 cases, with 32 disks examined. Nine were 5th lumbar-1st sacral, 1 a 4th-5th lumbar, 2, 3rd-4th lumbar. There was degeneration, as in group C, but also a posterior or lateral rupture with a spreading of the contrast material which sometimes contained particles of tissue. The roentgenogram of the spine showed a normal interspace in only 3 cases, with the changes in the others more pronounced than in the preceding groups. Myelography was not performed in 3 cases. Of the remaining, 4 were normal, 7 showed slight deformity and 7 showed prolapsed disks.

Clinically, pain on coughing and a positive Lasègue sign were the most common findings.

Operation in 4 cases of this group confirmed the myelographic impression.

In concluding, the author states that pain on disk

injection is much more frequent in disks with rupture than without. However, radiating pain, although provoked by injection, is not an indication for surgical treatment. In disk rupture with spread of the contrast material there is an indication for surgery only if tissue sequestra are found in the spreading contrast material, or if there is a bulging of the edges of the rupture. If these conditions are absent, negative findings on operation are to be expected, and in these cases treatment should be conservative. In verified disk prolapse, puncture may demonstrate a degenerated disk but no rupture; those are the degenerated disks with local posterior bulging.—*Arthur B. Smith, M.D.*

Lawson, F. L. Paravertebral teratoid tumor with scoliosis; report of cases. *J.A.M.A.*, Jan. 24, 1953, *151*, 271–275.

The case of a three year old boy with gross scoliosis due to a teratoid involvement of the vertebral column is reported and discussed. The case of a three month old boy with an intrathoracic teratomatous growth apparently arising from the spinal arachnoid is also recorded.—*James J. McCort, M.D.*

Gondos, Bela. Calcification about the wrist associated with acute pain (periarthritis calcarea); clinical and roentgenological study. *Radiology*, Feb., 1953, *60*, 244–251.

The author discusses calcification about joints in general and reports 8 cases of calcification about the wrist associated with severe pain, and presents 5 cases. In 4 cases the calcification occurred in the area of the flexor carpi ulnaris tendon. In the remainder the areas of the flexor carpi radialis, the common flexor tendons, and the extensor carpi ulnaris tendons were involved. In 1, the calcium deposit was medial to the styloid process of the ulna. Emphasis is placed on the fact that different structures may be simultaneously involved.

Diagnosis is made on the basis of roentgen examination. Cases of a chronic nature show an intense and well defined calcific shadow while acute cases show faint and ill defined calcification. Posteroanterior, lateral and oblique views are necessary for good visualization of these shadows.

Characteristically this disease is usually a self-limited one with the pain generally disappearing within two weeks during which time the calcium shadow diminishes in size or disappears.—*Donald N. Dysart, M.D.*

Jeffery, C. C. Fracture separation of the upper humeral epiphysis. *Surg., Gynec. & Obst.*, Feb., 1953, *96*, 205–209.

In December, 1949, it was decided to attempt manipulative reduction of a fracture separation of the upper humeral epiphysis. This was easily achieved under general anesthesia by traction on the upper limb in a position of hyperabduction—abduction to at least 135 degrees—30 degrees forward inclination, and neutral rotation accompanied by pressure on the bony prominence of the displaced upper end of the shaft. Reduction was lost as soon as the arm was brought down even to right angle abduction. Therefore, after remanipulation the limb was immobilized in the position already described. The intact soft tissues on the medial and posterior aspects were thus placed in a state of tension so as to maintain reduction and at the same time to allow the torn soft tissues on the anterolateral aspect to fall together. A neutral position of rotation was used as the rotator muscles which remain attached to the upper fragment are approximately equally balanced. Skin extension and light traction over a suitably placed pulley were employed to maintain reduction. After three weeks' immobilization shoulder exercises were started. The same method of treatment was subsequently used in 4 other patients. In all 5 patients good reduction was obtained and held, union was rapid, and full function restored within three months. There were no complications and there was no evidence of traction injury to the brachial plexus.

After a search of the literature, the author found that this method of obtaining reduction had been described in detail by Royal Whitman as long ago as 1908.—*Mary Frances Vastine, M.D.*

Greenhut, Irene J., Silver, Richard A., and Campbell, John A. Occurrence of gout in a female; report of an unusual case. *Radiology*, Feb., 1953, *60*, 257–260.

Gout is predominantly a disease of males with only about 5 per cent of the reported cases being in females.

The authors present a case study of a twenty-eight year old woman in whom a diagnosis of gout was made one year previously. Roentgenograms revealed gouty arthritis involving the ankles, feet, toes and wrist. Many nodules were present over various bony prominences and biopsy of several of these, together with chemical analysis, showed them to be composed of 95 per cent urates.

The patient had a rapid development of her disease and an accompanying amenorrhea along with the gouty arthritis.—*Donald N. Dysart, M.D.*

Blood and Lymph System

Ingram, M.; Adams, M.; Coonan, L.; Jespersen, J.; Nielsen, G.; Piatt, D.; and Yettewich, G. The occurrence of lymphocytes with bilobed nuclei in cyclotron personnel. *Science*, Dec. 26, 1952, *116*, 706–708.

Hematologic monitoring was instituted as a part of the health program for cyclotron personnel in July, 1948, at the University of Rochester. A pre-

liminary report called attention to an increased incidence of lymphocytes with bilobed nuclei in cyclotron personnel during its early operation. The present paper reviews the data of the monitoring from 1948, when the initial crew was assembled, through 1952.

A definite increase in lymphocytes with bilobed nuclei occurred in the group as a whole during the early periods of the cyclotron operation. There were two incidents in which specific persons were exposed. These persons showed several lymphocytes with bilobed nuclei within two weeks of exposure. The findings in these persons were excluded from the data presented on the group, since they had known exposures. In April, 1949, a protective dike of concrete and earth between the cyclotron building and laboratory was completed. Since completion of the dike, the number of smears containing one or more lymphocytes with bilobed nuclei has returned to a level about equal to that for the control group.

Lymphocytes with bilobed nuclei may appear in increased numbers in conditions other than exposure to ionizing radiations, such as infectious processes or leukemia. The occurrence of an occasional cell of this type in the controls may reflect the normal incidence of low-grade infections in the group as a whole.

The examination for the presence of these cells is practical when it is desirable to add biological monitoring as an adjunct to physical monitoring because (1) the increased occurrence of binucleate lymphocytes appears to be related to exposure to exceptionally small amounts of ionizing radiation, and (2) lymphocytes may be obtained readily from examination.—*Norman Heilbrun, M.D.*

Walker, R. Milnes, Middlemiss, J. H., and Nanson, E. M. Portal venography by intrasplenic injection. *Brit. J. Surg.*, Jan., 1953, *40*, 392–395.

Demonstration by Albeatici and Campi (1951) that an opaque medium injected into the spleen rapidly enters the venous system and is carried to the liver in sufficient concentration to outline the veins opened a new field in portal venography. The authors describe their method which consists of transabdominal splenic puncture with a wide-bore needle following local anesthesia. In all of the 12 cases examined the spleen was enlarged. Injection is made about 4–5 cm. above the costal margin through the interspace in line with the apex of the spleen. Respiration is held during the puncture. Thirty milliliters containing 70 per cent diodone (diodrast) is injected rapidly. The exposure is made after the completion of the injection.

The authors present several illustrations of normal and abnormal cases. The splenic vein and portal vein are normally well outlined. If there is block of the portal vein, the collateral circulation is outlined. The method used following shunting operations determines whether portal hypertension still exists or not. Its greatest use, however, lies in the demonstration of veins suitable for portal systemic anastomosis.

Only on one occasion, when the procedure was performed during laparotomy with the patient breathing, did a splenic hemorrhage occur.—*Lawrence A. Davis, M.D.*

Berger, James S., Forsee, James H., and Furst, John N. Splenic arterial aneurysm. *Ann. Surg.*, Jan., 1953, *137*, 108–110.

Splenic arterial aneurysm in early adult life is twice as common in the female as in the male, with a disproportionate number occurring in the pregnant female. In the older age group, the ratio in male and female is about equal.

The surgical mortality prior to rupture is 15 per cent, after rupture the mortality nears 100 per cent. The need for diagnosis before rupture is therefore apparent. The main etiologic factor is arteriosclerosis, less commonly the aneurysm is mycotic and rarely it is considered to be congenital. Rupture into the general peritoneal cavity is infrequent, into the lesser omental bursa more frequent. The latter type of rupture may result in a tamponade effect with prolonged bleeding and occasionally perforation into the stomach, duodenum or colon with production of melena or hematemesis.

In the reported case a roentgenogram of the abdomen revealed two calcific densities in the left upper quadrant with stippled, mottled centers. Translumbar arteriography clinched the diagnosis, which was confirmed by surgical exploration and splenectomy. Roentgenograms of the gross specimen showed calcified densities with "broken egg shell" circumferences. Recovery was uneventful.—*C. N. Borman, M.D.*

General

Pendergrass, Robert C. The radiologist in the rural tumor clinic, his problems and opportunities. *Radiology*, Dec., 1952, *59*, 841–843.

The radiologist in a clinic where the diagnosis and treatment of cancer is undertaken is an integral part of the group. His opinion must often be the deciding factor in the choice of treatment of tumors, and he must serve the patient's best interests in his decision. He should keep abreast of the advances in fields other than his own in order to offer the best type of treatment. His pride must not be such that he will not recommend other clinics or treatment centers where there are better facilities for the problem at hand. Above all, the radiologist must make himself so cancer conscious that he will always be on the lookout for early cancers when they are in curable stages.

He must depend on the skill and judgment of his colleagues in other specialties to aid him in arriving

at the correct diagnosis and in aiding in the management of the patients requiring radiation therapy. The value of radioactive substances in diagnosis and treatment must be known so he can counsel wisely with his colleagues and his patients.

His greatest opportunities come in his chances to stimulate interest in cancer among the physicians of his own and neighboring communities by case presentations and consultations. By quiet talks with his patients he can teach them that early cancer is curable. His association with his patients who have cancer will give him great personal satisfaction when he is able to cure them or make them more comfortable during their last trying days.—*Donald N. Dysart, M.D.*

Holman, Colin B. Roentgenologic manifestations of vitamin D intoxication. *Radiology*, Dec., 1952, *59*, 805–816.

Various types of calcification seen on roentgenograms of 56 patients in whom a diagnosis of vitamin D intoxication was made are described. Symptoms associated with the gastrointestinal tract, the urinary tract and central nervous system are reviewed.

The types of calcification are classified as physiologic, vascular and pathologic.

Although physiologic calcification has been produced in the lungs, stomach and kidneys of experimental animals, no such roentgenographic changes were observed in any of the 56 patients of this series.

Vascular calcification was seen in only 18 of the 56 patients. It is concluded that although hypervitaminosis D is undoubtedly associated with the production of vascular calcification, the presence of such deposits is not pathognomonic of vitamin D intoxication.

Pathological calcification was seen in 8 patients all of whom had evidence of renal insufficiency, a high concentration of blood phosphorus, and advanced rheumatoid or gouty arthritis. Three types of pathological calcification were observed. In patients with rheumatoid or gouty arthritis, there was seen either a putty-like deposit of calcium in the periarticular tissues of joints or similar deposits in the bursal sacs or rheumatoid nodules. The third type seen with tophaceous gout was characterized by dense granular calcium deposits in the regions of the tophi, probably having been deposited with or around urate deposits.

Roentgenographic reproductions illustrating the various types are included.

It is concluded that only pathologic calcification appears to be sufficiently indicative of vitamin D poisoning to be of primary diagnostic significance.—*Everett E. Seedorf, M.D.*

Poutasse, Eugene F., and McCullagh, E. Perry. Cushing's syndrome. *J. Urol.*, Nov., 1952, *68*, 779–789.

The diagnosis of Cushing's syndrome is relatively easy. The patient has a characteristic facial appearance. There is plethora with a round "moon face." The disease is more common in women and various degrees of hirsutism may be present. The neck is short and obese, and there is a "buffalo" hump of fat in the cervicodorsal region. The abdomen protrudes because of obesity and weakened musculature. The limbs appear to be wasted and flabby. The skin is thin and the blood vessels are more evident than in normal people. Purplish striations occur in the upper thighs and abdomen. Varying degrees of hypertension are found. Associated with this hypertension there is some cardiac hypertrophy and possibly cardiac failure. Diabetes mellitus, which is insulin resistant, is a frequent complication. Roentgen examination of the vertebrae and skull may demonstrate various degrees of osteoporosis, and pathological fractures are sometimes found in the vertebral bodies. The posterior clinoid processes of the sella turcica may become so osteoporotic that the appearance is mistaken for erosion of the dorsum. The hemoglobin and the red blood cell count may be increased while the lymphocyte count is diminished. In some patients there is considerable alteration of blood chemistry, such as low serum potassium, elevation of serum sodium and a low chloride in the plasma. Pyelonephritis and renal calculi are not infrequent, particularly when the patient has hypercalcinuria. The urinary corticoid levels by present chemical tests are not usually diagnostic. A number of women with Cushing's syndrome show various degrees of masculinity. These patients do not usually exhibit the muscular weakness of some of the other cases.

Cushing's syndrome is a progressive disease which greatly shortens life expectancy. The clinical picture is caused either by an adrenal tumor or by bilateral adrenal hyperplasia in practically all instances. Patients who are suspects should have intravenous urograms, translumbar aortography, laminagraphy, and perhaps perirenal air insufflation as preoperative diagnostic studies because the localization of an adrenal tumor greatly simplifies the surgical problem. However, in most instances, no tumor can be demonstrated and therefore bilateral operation is necessary.

The authors recommend the removal of about four-fifths of one adrenal and the total removal of the other adrenal. This procedure can be carried out either by a two stage operation, as in the case which they report in their article or by a single stage operation with the proper use of ACTH and cortisone before and after surgery.

Of the 22 patients mentioned in this article who were operated upon or later came to autopsy, 16 were found to have bilateral adrenal hyperplasia. In 5 instances, there was either a cortical adenoma or a carcinoma of one adrenal. It should be noted that the size of the tumor is not directly related to its functional ability, so that a small adenoma is just as capable of producing the syndrome as a large tumor.

There is some evidence that the basophil cells of the pituitary gland undergo secondary changes following adrenal hyperplasia or the development of an adrenal cortical tumor, but in some isolated instances the syndrome may be initiated by a pituitary basophilic tumor with resultant adrenal hyperplasia and hyperfunction.

The classical picture of Cushing's syndrome is due to a hypersecretion of eleven oxysteroids. The syndrome can be induced artificially by ACTH, cortisone or compound F.

In those patients in whom a basophilic pituitary adenoma is suspected as the antecedent cause, roentgen therapy can be tried prior to operation. When this fails, operation upon the adrenals is indicated The hazards of this operation have been greatly diminished by the use of cortisone and ACTH.—*George W. Chamberlin, M.D.*

RADIATION THERAPY

Wachtler, F. Hydroperikard nach Röentgenbestrahlung. (Hydropericardium after roentgen irradiation.) *Radiol. clin.*, Jan., 1953, *22*, 1–9.

The author reports in detail 2 patients who, following postoperative roentgen irradiation of carcinoma of the breast, developed pulmonary changes associated with hydropericardium.

The first patient received three series of treatments during a period of six months, beginning a few weeks after radical mastectomy. Two small fields of 8 by 10 cm., one each for the axilla and the supraclavicular region, and one large field of 20 by 24 cm. over the left hemithorax anteriorly were used. The total dose per field amounted to 3,500 r with 190 kv., 0.5 mm. Cu plus 1 mm. Al at 50 cm. skin target distance.

The second patient underwent a radical mastectomy without the addition of roentgen therapy. Seven years later she developed metastases to the upper mediastinum. These were irradiated through a single anterior field, 10 by 10 cm. in size, with 6 fractions of 330 r within a week. Two months following this treatment a left-sided pleural effusion appeared, which in turn was irradiated through three large thoracic fields by administering a dose of 1,000 r over each field, and two months later another dose of 800 r over each field. The factors employed were the same as in the first case.

Both patients developed rather pronounced radiation pneumonitis of the left lung associated with marked hydropericardium. Follow-up roentgen studies of the chest revealed later gradual change of the pneumonitis into moderate pulmonary fibrosis with concomitant clearing up of the hydropericardium. The first patient is relatively symptom-free three years after the operation, while the second patient died nine years after the operation with generalized carcinomatosis.

The author states that although pulmonary fibrosis incidental to roentgen irradiation of the thorax is a frequent manifestation, hydropericardium is observed very rarely. In the 2 cases reported, causal connection with the roentgen irradiation was assumed since (a) the dose reaching the intrathoracic structures was sufficiently large to produce radiation injury, (b) the heart was included within the irradiated volume and (c) the changes made their appearance at an interval and under circumstances suggestive of irradiation effect. An important diagnostic point is that hydropericardium caused by roentgen irradiation is nearly always accompanied by pulmonary changes due to the fact that the lung is somewhat more radiosensitive than the heart and the pericardium. On the same basis a diseased heart muscle is more apt to lead to pericardial effusion than a normal heart muscle.

The 2 cases are illustrated with reproductions of chest roentgenograms made at the time the hydropericardium was at its maximum and one and one-half to two years later after the hydropericardium had cleared up.—*T. Leucutia, M.D.*

Crissey, John T., and Shelley, Walter B. A controlled clinical study of the effect of x-ray therapy in certain nonmalignant dermatoses. *New England J. Med.*, Dec. 18, 1952, *247*, 965–970.

The authors report their observations on the rate of clearing of irradiated and nonirradiated lesions of six nonmalignant dermatoses. They found a consistent and significantly greater response in the irradiated cases of lichen simplex chronicus, lichen planus and psoriasis. They do, however, point out that the use of irradiation on such cases as psoriasis is usually not indicated because of the chronicity of the disease and the tendency to overtreatment.

Irradiation had slight beneficial effect in cases of nummular eczema, contact dermatitis and acne vulgaris.—*Robert L. Raphael, M.D.*